1.1 Symptom Investigation

Effects
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00:00:10
Hi and welcome to lecture 1.1 symptom investigation.

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The objectives here for lecture 1.1 are to, let's see here,

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Summarize why a body diagram may provide useful information, describe the use of open and closed-ended questions as a component of symptom investigation.

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Describe how knowledge of potential pain location patterns associated with viscera, can be beneficial and how it can also be confounding.

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And finally, identify three questions you might ask a patient regarding the onset of their symptoms and describe the appropriate time frame over which to assess changes in their symptoms.

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Symptoms investigation.

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So we use a body diagram for noting the exact location of symptoms and descriptors of the symptoms.

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For example, aching or burning or shooting pains, as well as peristysia, numbness, and weakness.

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We try to use open-ended questions to avoid leading or biasing the conversations.

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So examples might include things like, how are you feeling today?

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What brings you in today?

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What seems to be bothering you the most today?

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Those are examples of open-ended questions.

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The answer could prompt you to ask, are you more sore today than usual or does your pain move around or does your pain increase or decrease in intensity?

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The authors of your Boston Notebook recommend asking do you have symptoms anywhere else?

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I'm generally more cautious about this, I may return to this question eventually, but to avoid confusion or over complication, initially the focus is on the patient's chief complaint at least in my experience.

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Symptom investigation, follow up questions.

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So ask follow up questions to help rule out potential diagnoses, noting other complaints or symptoms could be useful here.

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As you become experience, screen at least one joint or body region above, and one joint or body region below the patient's area of chief complaint.

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So the patient with low back pain states my back hurts.

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A follow-up question may be have you experienced any numbness or tingling in either leg.

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Any progressive loss of strength?

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Any increasing frequency of tripping, or have you experienced a fall recently?

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Asking the patient about any other complaints like nausea, fever, abdominal pain, upper back, or shoulder pain could be useful for suggesting follow-up questions or screening to rule out serious pathology.

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Overlapping pain patterns, and one of the important things that you'll see frequently here in these presentations is to see a specific table and this one is table 5.1 in your book.

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Your book also includes a number of boxes and figures and I'll refer to those quite often.

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It just seems to be the the format of the book and that's how the author put it together.

00:03:43
Lots of tables, lots of figures, lots of boxes.

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So there's considerable overlap between pain referred from musculoskeletal structures and pain associated with visceral disorders.

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Certain pain descriptions may be unusual for musculoskeletal pain.

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So vascular disorders could present with a patient complaining of throbbing or pounding or pulsating kinds of symptoms.

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Neurologic disorder could present with symptoms that a patient might describe as sharp or shocking or burning.

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And visceral disorders could present with symptoms such as aching, squeezing, gnawing, burning or cramping.

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The symptom descriptions alone don't really contain enough information to diagnose or base any kind of referral.

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Knowledge of potential pain location patterns associated with viscera can guide the PT and selecting the organ systems to screen further with questions related to a review of symptoms.

00:04:44
Symptom onset, so information about when the symptoms began should be obtained.

00:04:51
And is this the episode that started everything?

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Is there a multi year history?

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Can the patient point to a specific inciting event?

00:05:00
So many patients cannot relate the onset of their symptoms to any particular incident or accident.

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However, if you question them carefully, you can often uncover a likely cause, such as the patient beginning to run after not having run for three months, or being promoted to some kind of position that requires sitting at a desk for eight hours a day.

00:05:21
Or starting to return to gardening, or yard work after the winter.

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If the onset of symptoms is truly insidious, if new symptoms occur during the course of treatment, or if resolved symptoms return for no apparent mechanical reason, then you should begin having some questions about the underlying nature of the condition.

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00:05:47
Behavior and pattern of symptoms.

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So has the intensity of the symptoms changed over time?

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Are symptoms affected by activity versus rest, or by the patient's position, or the time of day?

00:06:01
Is the behavior of the symptoms generally predictable over a 24-hour period?

00:06:06
So for many patients with neuromusculoskeletal disorders, a description of how symptoms do or do not change over a 24-hour period is adequate.

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For patients with disorders such as multiple sclerosis, stroke, or head injury, the appropriate time frame may be three to six months for symptoms to change.

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If the symptom pattern reveals no consistency, then you should begin questioning whether physical therapist intervention is warranted.

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The inconsistent symptom pattern combined with location of symptoms should alert you to screen specific body symptoms later in the examination.

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However, if for example, the patient's thoracic pain increases after eating, you may begin to consider whether GI pathology is present.

00:07:01
So here's an example of a sequence of questions you may ask your patient.

00:07:05
Which of your symptoms is interfering most with your normal function?

00:07:10
Can you explain why these symptoms may have begun?

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Describe the symptoms, do the symptoms spread to any other body, regions or parts?

00:07:19
Please rate the intensity of your symptoms on a 0 to10 scale.

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00:07:24
Was there a recent injury or any flare-up of your symptoms?

00:07:29
Is your pain constant or does it come and go?

00:07:33
What things tend to make your pain worse or better?

00:07:36
Does your pain wake you up at night?

00:07:39
Have you had any previous episodes with similar symptoms?

00:07:42
Do you have symptoms anywhere else, and if the answer is yes, repeat the appropriate previous questions.

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1.2 The Low Back and Lower Extremities; Regional Pain Patterns and Associated Disorders

00:00:01
Lecture 1.2, regional pain patterns and associated diseases and disorders, low back and lower extremities.

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So the objectives here are to identify 4 forms you might give to a patient with low back pain to provide additional information about that patient's condition.

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Describe at least two non-musculoskeletal causes of low back pain and under what circumstances you might reevaluate a musculoskeletal cause of labaquine.

00:00:34
Describe symptoms which might lead you to include cauda equina in your list of differential diagnoses.

00:00:42
Identify five potentially serious conditions which may mimic less serious musculoskeletal conditions in the pelvis, hip, and thigh.

00:00:52
And finally, identify five potentially serious conditions which may mimic less serious musculoskeletal conditions in the knee, lower leg, ankle, and foot.

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00:01:06
Low back pain questionnaires and forms.

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So some of these forms include the modified oswestry low back pain disability questionnaire.

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Usually you'll see that abbreviated and this is an outcome measure.

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Another one is the Fear Avoidance Belief Questionnaire.

00:01:21

Again, this is usually abbreviated FABQ.

00:01:26
Common Medical History Intake Forms, and then finally a Red Flag Screening Form could be included, and we'll learn more about these as the class progresses.

00:01:36
So a patient with low back pain presenting to your clinic may be given multiple forms to fill out to try and obtain as much useful information about the case as possible.

00:01:48
Low back pain, cause of pain.

00:01:51
If a patient is over 55 and is failing to improve, it may be appropriate to consider non musculoskeletal causes of the low back pain.

00:02:00
Or, it may be appropriate to inquire about an infection as the cause of the patient's low back pain.

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If the patient notes that their comfort does not change in any position, the likelihood that the pain is not musculoskeletal in origin increases.

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So asking the patient about a history of trauma, osteoporosis, or other disorder that may decrease bone density may help you rule out spinal fracture as a cause of the patient's pain.

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So a physical therapist asks the 55 year old patient the following questions to increase or decrease, there's suspicion that this patient's low back pain is caused by cancer.

00:02:42
Do you have a history of cancer?

00:02:44
If so, what type of cancer?

00:02:47
Have you recently lost weight, even though you have not been attempting to eat less or exercise more?

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If you have, how much weight have you lost?

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When asking about infection, questions such as, have you recently had a fever?

00:03:00
Or have you recently taken antibiotics for an infection or have you been diagnosed with an immunosuppressive disorder can all provide you with useful information.

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00:03:14
Cauda equina, to rule out cauda equina, asking about changes in bowel or bladder habits as well as saddle paresthesia and lower extremity weakness can be useful.

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A positive response to any of these questions increases the suspicion that the patient has cauda equina syndrome.

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You can follow these inquiries with a physical examination assessing sensory integrity of the perianal and perineal areas, as well as the L4, 5, and S1 dermatomes.

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You can also assess motor integrity of L4, the quadriceps and tibialis anterior or L5 and S1 musculature.

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Pelvis, hip and thigh.

00:04:02
Colon cancer, femoral neck fracture, osteonecrosis, Legg-Calve-Perthes, and slipped capital femoral epiphysis can all mimic common musculoskeletal disorders of the pelvis, hip and thigh.

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In older populations, proximal femur fractures become increasingly likely.

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Patient demographics, age, sex, etc, and a detailed health history are important.

00:04:28
Medications affecting bone density are also important screening components.

00:04:33
Leg calf perthes is most common in 5-8 year old boys and they often report groin, thigh and knee pain that worsens with weight bearing activities.

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Slip capital femoral epiphysis occurs in adolescents and 2-1 in boys vs girls.

00:04:51
Symptoms include groin, thigh or knee pain and limited hip internal rotation range of motion.

00:04:58
Pathologic fractures of the femoral neck occur secondary to disease and often in the absence of major trauma.

00:05:05
These fractures are most common in individuals over 50 years, women more often than men, and patients who have a history of metabolic bone disease, such as osteoporosis or Paget's disease.

00:05:18
A history of a fall from a standing position is often reported, along with a feeling of a sudden painful snap in the hip region and giving way.

00:05:26
Acute groin pain is usually reported.

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In Legg-Calve-Perthes disease, this condition results from an idiopathic loss of blood supply From the lateral ascending cervical artery to the femoral head.

00:05:40
Patients with osteonecrosis and Legg-Calve-Perthes disease often report pain in the groin, thigh, and knee that worsens with weight-bearing activities resulting in an antalgic gait.

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Common clinical findings in children with Legg-Calve-Perthes disease also include shortening of the involved leg.

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Unlimited internal rotation and abduction of the involved hip.

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00:06:06
Knee, lower leg, ankle and foot and deep vein thrombosis.

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Compartment syndrome deep vein thrombosis, peripheral arterial occlusive disease, septic arthritis, and cellulitis, are all serious conditions to consider in this region, in this region being the knee, lower leg ankle and foot.

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Peripheral vascular disease often includes aching and buttock thigh and calf that increases with activity and improves with rest.

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A DVT may manifest as calf pain that increases with activity, but half of DVT patients do not experience calf pain.

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Risk factors for DVT include recent surgery, malignancy, trauma, prolonged immobilization and pregnancy.

00:06:57
Peripheral vascular disease.

00:06:59
Usually can be sussed out by looking at pedal pulses and whether they're decreased and also looking for wounds and sores on the toes or feet of patients.

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00:07:12
Continuing with knee, lower leg, ankle, and foot, compartment syndrome.

00:07:16
Compartment syndrome is a result of swelling inside a connective tissue compartment.

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Usually it's a result of trauma or a rapid increase in physical activity.

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Symptoms of compartment syndrome include pain when a stretch is applied to the involved muscle.

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Keep in mind the six Ps of compartment syndrome, pain, palpable tenderness, paraesthesia, paresis, pallor, and pulselessness.

00:07:42
So, with compartment syndrome the physical examination typically reveals swelling, tenderness and palpable tension of the involved compartment.

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The nerve entrapment or compression found in this condition results in paresthesias, and potentially in paralysis.

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The vascular compromise accompanying this condition results in diminished peripheral pulses and, potentially, a change in skin color.

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00:08:14
Finally, septic arthritis and cellulitis continuing in the knee, lower leg, ankle, and foot.

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Septic arthritis is an inflammation in a joint caused by a bacterial infection.

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Cellulitis is an infection in the skin after a wound becomes contaminated by bacteria.

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Patients who have septic arthritis complain of a constant aching or throbbing pain and a swelling in a joint.

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The involved joint is usually tender and warm when palpated.

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And depending on which joint is involved, erythema may be present.

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Patients who develop septic arthritis often are immunosuppressed or have pre-existing systemic joint disease.

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An infection in the tissues, cellulitis, exhibits the classic signs of pain, skin swelling, warmth.

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And advancing irregular margin of erythema or reddish streaks, suspicion of either septic arthritis or cellulitis would warrant an immediate referral of the patient to a physician.

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1.3 The Thoracic and Trunk Regions; Regional Pain Patterns and Associated Disorders

00:00:02
Hi there, so continuing with Lecture 1.3 on regional pain patterns and associated disorders, we'll now be focusing on the thoracic and trunk region.

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So the objectives for this lecture include identify four general non-musculoskeletal conditions.

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Changing the color here, which may produce thoracic trunk pain.

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Define angina, describe at least three risk factors and describe the difference between stable and unstable angina.

00:00:34
Provide a general definition of each of the following, pericarditis, pulmonary embolus, pleurisy, and cholecystitis.

00:00:43
Identify symptoms of non-duodenal ulcers which may be associated with malignancy.

00:00:49
Describe symptoms which may be associated with pyelonephritis and kidney stones.

00:00:55
Thoracic pain, cardiac and pulmonary disorders.

00:00:59
Cardiac, pulmonary, gastrointestinal, and urogenital conditions may recreate pain in this region.

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Myocardial infarction may feature angina, left arm pain, epigastric, midthoracic spine pain, right shoulder pain, neck, jaw, or tooth pain.

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1 in 3 patients, however, may not experience chest pain.

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Dyspnea, nausea, palpitations, or syncope may be the only symptoms patients present with.

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Risk factors include, a history of diabetes, age, being female, nonwhite, a history of congestive heart failure or a history of stroke.

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Unstable angina is chest pain that occurs outside of a predictable pattern and does not respond to nitroglycerin.

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Individuals experiencing unstable angina must be closely monitored.

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Signs suggesting myocardial infarction such as subternal squeezing or crushing pressure, pain radiating into both arms, shortness of breath, pallor, diaphoresis.

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Or angina lasting more than thirty minutes, should alert the therapist that immediate transportation of the patient to an emergency department or coronary care facility is indicated.

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Thoracic pain continued, pericarditis is an inflammation of the pericardium and symptoms may include left shoulder and arm pain.

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And a pulmonary embolus and blood clot is involved in this can produce substernal shoulder or upper abdominal pain.

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Pleurisy and pneumothorax are 2 other conditions that may cause chest pain.

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With pericarditis, inflammation prevents complete expansion of the heart, resulting in less blood leaving the heart, to make up for the reduced stroke volume and to get enough oxygen to the tissues, the heart beats faster.

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If increased heart rate cannot compensate enough, the individual may start to breathe heavily and the veins in the neck may distend and blood pressure may decrease drastically during inhalation.

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This condition is termed cardiac tamponade, and should be considered a medical emergency.

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In addition to chest pain, patients with pulmonary embolus may develop

dyspnea, wheezing and a marked decrease in blood pressure.

00:03:24
Factors that increase the risk for blood clots in the lower extremities or pelvis, and subsequent embolus include immobilization or recent surgery.

00:03:33
Two patient types that therapists frequently treat, patients who've had recent surgery or been immobilized.

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Pulmonary embolism also has a high mortality rate, so if the physical therapist suspects this condition, the patient should immediately be referred to emergency care.

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Pleurisy is an irritation of the pleural membranes that make up the lining between the lungs and the inner surface of the rib cage.

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The pain that pleurisy produces is characteristically described as sharp and stabbing, and the pain is worsened by deep inspiration and other ribcage movements such as cough, bending, and reaching activities.

00:04:14
Thoracic pain, gastrointestinal disorders, gastric or peptic ulcers are common disorders that may cause thoracic pain.

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Gastric ulcers outside of the duodenum may be associated with malignancy.

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Symptoms may include black, tarry stools, red clumps and vomit, changes in pain with eating, or pain in the chest or back.

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Cholecystitis is an inflammation of the gall bladder, and may cause pain in the right upper abdomen, interscapular or right scapular region.

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Duodenal ulcers manifests as dull nine or burning pain in the epigastric region, in the mid thoracic region, or in the supraclavicular region.

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These symptoms occur when the stomach is empty, and are relieved with

eating or taking antacids.

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Relief is temporary, however, and the symptoms return within two to three hours.

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If the ulcer is located in the stomach, which is a gastric ulcer, eating may increase rather than relieve the symptoms.

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With regards to cholecystitis, patients initially may present to therapy with shoulder or mid back pain.

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But suspicion of this condition should result in immediate referral to their physician.

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Kidney disorders, pyelonephritis and renal stones may cause pain in the posterior thoracic and lumbar region.

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Often accompanied by chills, fever, nausea, vomiting and renal colic.

00:05:41
Pyelonephritis is a kidney infection, and kidney stones are hard salt precipitates from urine.

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Renal colic is excruciating intermittent pain from the costovertebral angle or flank that spreads across the lower abdomen.

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1.4 The Shoulder and Craniofacial Symptoms; Regional Pain Patterns and Associated Disorders

00:00:02
Hi and welcome back to Lecture 1.4, Regional Pain Patterns and Associated Disorders: Shoulder and Craniofacial Symptoms.

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So, the objectives for this lecture are to identify four serious underlying conditions which may produce cervical or shoulder discomfort.

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Identify three serious underlying conditions which may be responsible for craniofacial pain.

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Describe at least two symptoms associated with meningitis and subarachnoid hemorrhage.

00:00:39
Identify three items from a patient's history that may increase the likelihood of a brain tumor as a source of craniofacial pain.

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Central cord syndromes, ligamentous instability, brachial plexus neuropathies, and Pancoast's tumor may be responsible for shoulder and or cervical pain.

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Special tests for cervical instability have a high likelihood of bias and questionable diagnostic accuracy.

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Before performing any of these tests, utilize the Canadian C-Spine rules.

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Tingling, weakness, numbness, or burning in more than one extremity, clonus or Babinski's signs may suggest spinal cord pathology.

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Brachial plexus neuropathies may affect sensory, motor, or mixed nerves.

00:01:27
The therapist should conduct a thorough examination of motor and

sensory function, and reflexes in the area of interest.

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Pancoast's tumor is a malignant tumor in the lung, most often occurring in men over age 50 who have a history of smoking.

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In 90% of patients, shoulder pain appears before pulmonary symptoms.

00:01:48
Regarding neuropathic pain, you should carefully observe the area, preferably with the area disrobed to allow for bilateral comparison of muscle bulk and to note possible atrophy.

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If you suspect a specific nerve, you should consider the muscles and sensory distribution that would be affected.

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Pancoast's tumor, initially, patients with Pancoast's tumor typically have nagging pain in the shoulder and along the vertebral border of the scapula as the tumor irritates the parietal pleura.

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As the tumor continues to invade the thoracic inlet, the pain becomes burning in nature, extending down the arm and into the ulnar nerve distribution.

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Over time, the intrinsic hand muscles atrophy and the tumor occludes the subclavian vein.

00:02:36
Occlusion causes venous distension of the ipsilateral arm.

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Because of the slow progression, the disorder is undetected or misdiagnosed for an average of up to 6.8 months.

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Craniofacial pain.

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Meningitis, brain tumor, or a subarachnoid hemorrhage may be a cause of head, face, or jaw pain.

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Meningitis is more common in individuals with compromised immune systems, children under two years old, and individuals living in close quarters.

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The slump test to detect meningitis has a positive likelihood ratio of 0.97.

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So, this is not a great test for detecting meningitis.

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A history of breast, or lung cancer, or melanoma may increase the likelihood of brain tumor as a source of pain.

00:03:28
Subarachnoid hemorrhage may result in headache, meningeal irritation, fever, photophobia, nausea, vomiting, or neurologic dysfunction.

00:03:40
So regarding meningitis, an unexplained and progressive fever in children under the age of two, should warrant an immediate physician consult.

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Patients may demonstrate difficulty actively or passively flexing the neck and inability to touch the chin to the chest.

00:03:57
Although your text suggests using the slump test to screen for meningitis, use of it to diagnose meningitis was developed in the pre-antibiotic era and in patients with severe late-stage, untreated bacterial and tuberculosis meningitis.

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A recent study involving 297 adults with suspected meningitis revealed the positive likelihood ratio of 0.97, as I mentioned above.

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And it did not accurately discriminate between patients with and without meningitis.

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The test demonstrated diagnostic value in only four patients who had severe meningeal inflammation.

00:04:36
Instead, a headache that worsens after horizontally rotating the head at a frequency of two to three times per second may be more sensitive with a sensitivity up to 0.97.

00:04:50
Regarding brain tumors, although a headache is a symptom associated

with a brain tumor, neurologic deficits are a more common symptom in the early and middle stages of this disorder.

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A change in mentation, vomiting with or without nausea, visual changes, seizures, ataxia and speech impairment are all possible presentations with or without headaches.

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Symptoms of this type would warrant a detailed neurologic screening.

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1.5 The Elbow, Wrist, and Hand Pain; Regional Pain Patterns and Associated Disorders

00:00:01
Hi, welcome back, and welcome to lecture 1.5, Regional Pain Patterns and Associated Disorders, Elbow, Wrist, and Hand Pain.

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So our objectives for this section are to identify 3 factors which may increase, change the pen color here, susceptibility to more serious elbow, wrist, and hand injuries.

00:00:27
Summarize Grade I, Grade II, and Grade III soft tissue injuries.

00:00:31
Describe 4 factors which may raise suspicion of an infection in a patient's hand.

00:00:37
Summarize important components of an examination of the upper extremity for infection, including 4 specific factors, the presence of which are associated with most major hand infections.

00:00:51
Describe Raynaud's disease/phenomenon, including 3 questions you may ask your patient in an effort to increase or decrease the likelihood of this diagnosis.

00:01:01
Define complex regional pain syndrome and symptoms, which if present, may increase the likelihood of CRPS contributing to the patient's condition.

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00:01:15
Elbow, wrist, and hand pain.

00:01:17
Tauma-related injuries to the elbow, wrist, or hand should raise suspicion of serious injury.

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Osteoporosis, history of corticosteroid use, or a history of immunosuppression may all increase susceptibility to a more serious

injury.

00:01:36
Fractures of the elbow, wrist, and hand.

00:01:39
An elbow fracture is likely after a fall onto an outstretched hand or after direct trauma to the elbow.

00:01:46
Other common fractures include a distal radius fracture, scaphoid fracture, lunate, or capitate fractures.

00:01:53
In an elbow fracture, elbow extension is the function most impaired, and there may be a palpable gap between the olecranon and the trochlear notch of the humerus.

00:02:04
A fall also may cause anterolateral pain and tenderness, with an inability to supinate and pronate the forearm.

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Often the arm will be held against the trunk with the elbow flexed, with the patient demonstrating an inability to fully extend the elbow.

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In a distal radius fracture, known as a Colles fracture, this typically manifests with local pain.

00:02:27
Distal radius tenderness, swelling, and ecchymosis, and wrist extension in particular is very painful.

00:02:35
After a scaphoid fracture, the patient has similar signs and symptoms, but these are localized to the anatomic snuff box.

00:02:43
The wrist can also be very stiff, secondary to the swelling.

00:02:45
In a lunate or capitate fracture, the lunate fractures are rare and often are related to osteonecrosis while a capitate fracture is more common.

00:02:58
Patients present with symptoms similar to those of wrist pain, swelling, and tenderness at the mid-dorsal wrist area.

00:03:06
Capitate fractures are the result of trauma involving maximal wrist flexion or extension, however, instead of osteonecrosis.

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00:03:20
Soft tissue injuries of the elbow, wrist, and hand.

00:03:24
Grade I muscle strain stretches the tissue without disruption.

00:03:29
Grade II is a partial tearing of the muscle tissue while sparing the overlying fascia.

00:03:35
Grade III is a complete tear of the muscle and fascia resulting in a total loss of motion.

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00:03:44
Infection of the elbow, wrist, and hand.

00:03:47
Puncture wounds, abrasions, cuts, or other causes of skin disruption increase the likelihood of infection.

00:03:55
Fever, chills, a new onset of hand pain, or drainage should all raise your suspicion of an infection.

00:04:03
A patient's occupation may increase exposure to certain infectious agents.

00:04:09
So occupation such as an animal handler, even someone gardening, washing dishes, or working in a tropical fish store.

00:04:17
Immune status affects morbidity from hand infections.

00:04:21
So diabetes, chronic kidney disease, or malignancy, all affect morbidity.

00:04:27
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00:04:29
You want to take patient vital signs and expose the entire upper extremity for examination if you suspect an infection.

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Epitrochlear and axillary lymphadenopathy often accompany a forearm infection.

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00:04:43
We mentioned above, occupation, the patient's occupation may increase their exposure to certain infectious agents.

00:04:51
An animal handler may be prone to bite wounds that may become infected with organisms typical for involved species.

00:04:57
A rose gardener, for example, is at risk for infection through the introduction of spores through a cut or puncture wound in the skin.

00:05:05
Certain professions are more prone to chronic paronychia.

00:05:09
As an example, dishwashers are likely to develop candida infections, whereas a person employed in a tropical fish aquarium is more likely to develop another kind of infection after a hand injury, mycobacterium.

00:05:23
[BLANK_AUDIO]

00:05:29
And here are two images of infection.

00:05:32
On the left is erythema following a catfish sting and a subsequent infection.

00:05:37
And we can see here the redness, the area of erythema.

00:05:42
And this right here is the puncture wound from the catfish sting.

00:05:46
So on the right, this photograph demonstrates a dorsal subcutaneous abscess.

00:05:52
Note that the abscess is pointing, meaning that the skin is starting to thin from the pressure of the fluid underneath it.

00:05:59
And this indicates an impending rupture of the abscess.

00:06:03
So, I can see this,

00:06:04
[BLANK_AUDIO]

00:06:07
Whole area, and this is the pointing of the abscess.

00:06:11
[BLANK_AUDIO]

00:06:18
So this is another image of infection in the elbow, wrist, and hand.

00:06:25
And this is an example of skin necrosis with MRSA infection.

00:06:29
[BLANK_AUDIO]

00:06:38
Infection, diagnosing most hand infections.

00:06:41
The majority of hand infections can be diagnosed on clinical examination based on the presence of pain, erythema, abnormal swelling, or drainage.

00:06:50
[BLANK_AUDIO]

00:06:55
Raynaud's disease or Raynaud's phenomenon.

00:06:58
This is an exaggerated vascular response to cold or emotional stress.

00:07:03
Note color changes of the skin and fingers.

00:07:07
Raynaud's can be secondary to systemic lupus erythematosus and systemic sclerosis.

00:07:13
It's more common among young females and in families with a history of Raynaud's.

00:07:18
[BLANK_AUDIO]

00:07:23
Raynaud's diagnostic criteria, there are no simple tests or diagnostic criteria that can be used to diagnose Raynaud's.

00:07:30
The following questions, however, may be helpful.

00:07:33
Asking your patient, are your fingers unusually sensitive to cold?

00:07:38
Do your fingers change color when exposed to cold?

00:07:42
If the fingers change color, do they turn white, blue/purple, or both?

00:07:47
[BLANK_AUDIO]

00:07:51
So this is a flowchart of diagnosis of Raynaud's, and it starts with asking, has a typical episode of Raynaud's phenomenon been witnessed by a clinician or shown to the clinician in photographs or a video?

00:08:04
A typical episode of Raynaud is characterized by the following.

00:08:07
A sudden onset of cold fingers or toes, an association with sharply demarcated color changes of skin color, followed by cyanotic skin, so a white attack followed by a blue attack.

00:08:19
With re-warming ischemic phase, wider blue attack usually last 15 to 20 minutes.

00:08:26
The skin subsequently blushes and turns red or pink upon recovery.

00:08:31
So, if this has occurred, you want to evaluate for possible secondary causes of Raynaud's phenomenon.

00:08:39
If it has not occurred, then you want to ask the patient the following questions, and those are what we mentioned above.

00:08:45
Are your fingers unusually sensitive to cold?

00:08:48
Do your fingers change color when exposed to cold?

00:08:50
If your fingers change color, do they turn white, blue, or both?

00:08:56
So fingers are unusually sensitive to cold, but not associated with color changes, that's unlikely Raynaud's phenomenon.

00:09:02
If fingers change color when exposed to cold, that's possible Raynaud's phenomenon, if the changes are uniphasic.

00:09:11
If the fingers change color when exposed to cold and the changes are biphasic, then we can presume it's Raynaud's, and we evaluate for secondary causes of Raynaud's.

00:09:22
So it's a very complex flowchart,

00:09:24
[BLANK_AUDIO]

00:09:26
I don't expect you to memorize all this.

00:09:28
[BLANK_AUDIO]

00:09:30
So this is a picture of a typical episode of Raynaud's.

00:09:34
And on the left, we see that pallor in several fingers.

00:09:38
And on the right, we see the cyanosis at the fingertips

00:09:42
[BLANK_AUDIO]

00:09:50
Complex regional pain syndrome, CRPS.

00:09:53
CRPS is a disorder, usually affecting the distal limbs and is characterized by pain, swelling, limited motion, vasomotor instability, skin changes, and patchy bone demineralization.

00:10:08
The onset is often after a fracture or surgery.

00:10:10
The pathogenesis is unknown.

00:10:13
Pain is the most prominent and debilitating symptoms.

00:10:15
[BLANK_AUDIO]

00:10:18
There are often other symptoms, and various types of sensory abnormalities are common in CRPS.

00:10:23
About two-thirds of patients with CRPS have functional motor impairments related to pain.

00:10:29
Impairment is typically manifested by a reduction of complex muscle strength and hand grip, or during standing on your toes.

00:10:37
Limb movement may be limited by edema, pain, or contractures.

00:10:41
Some patients develop central motor manifestations such as tremor, myoclonus, dystonic postures, or impaired initiation of movement.

00:10:52
Autonomic changes can also occur, and that includes differences in skin temperature, skin color, sweat, or edema, these are common.

00:11:01
Skin changes can affect the connective tissue in CRPS.

00:11:05
And those may include increased hair growth, increased or decreased nail growth, contraction and fibrosis of joints and fascia, as well as skin atrophy.

00:11:16
[BLANK_AUDIO]

00:11:20
So we would consider CRPS if the following symptoms are present.

00:11:25
Number 1, pain, sensory changes, motor symptoms, autonomic dysfunction, or trophic changes, which develop after limb trauma, usually within four to six weeks.

00:11:37
Number 2, the symptoms are no longer fully explained by the initial trauma.

00:11:42
[BLANK_AUDIO]

00:11:43
And number 3, the symptoms affect the distal limb, they go beyond the region involved in the trauma, or they extend beyond the territory innervated by a single nerve or nerve root.

00:11:54
There is a more elaborate set of criteria compared to the three above, which includes possible imaging, and the clinical diagnostic criteria are comprised of the Budapest consensus criteria.

00:12:05
[BLANK_AUDIO]

00:12:10
CRPS and patient history.

00:12:13
Is the patient history consistent with a neurological or musculoskeletal issue that may respond to physical therapy treatment?

00:12:20
Does it make sense to you or does it seem off?

00:12:24

Given the patient history, have you decided whether other body systems or body regions, upper or lower quadrant, should be screened in addition?

00:12:33
The location of symptoms may alert you to warning signs for serious disorders.

00:12:38
Specific medical screening questionnaires and questions related to patient history will help you collect valuable information.

00:12:46
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2.1 Etiology of Joint Pain

Effects
00:00:00
[MUSIC]

00:00:08
[BLANK_AUDIO]

00:00:11
All right, so welcome to week two.

00:00:14
And we'll be talking about recognizing atypical symptoms and signs.

00:00:18
[BLANK_AUDIO]

00:00:23
So we'll begin by discussing etiology of joint pain.

00:00:27
[BLANK_AUDIO]

00:00:30
And our objectives include identifying 6 conditions associated with joint pain.

00:00:36
Describe why patient demographics may be important for diagnosing the cause of joint pain.

00:00:43
Summarize how a patient's subjective description of their symptoms may help determine a diagnosis, including the mnemonic components of OPQRST.

00:00:54
It's a pretty long mnemonic, but I'm hoping you're going to find it useful.

00:00:58
Patient demographics, medical history, and review of symptoms, make sure to look at your Boissonnault textbook Table 6.1, Box 6.1, Box 6.2, and Box 6.3.

00:01:10
There are a lot of tables and boxes in this section of your text.

00:01:15

So just prepare yourself for that.

00:01:18
Conditions associated with joint pain include ankylosing spondylitis, gout, reactive arthritis, septic arthritis, systemic lupus erythematosus, and rheumatoid arthritis.

00:01:31
Description of joint pain, patient demographics, and other health risk factors may provide clues related to development of a diagnosis or prognosis for a joint condition.

00:01:42
For example, rheumatoid arthritis is systemic while osteoarthritis is local.

00:01:48
Rheumatoid arthritis is a systemic illness, and it's often marked by extra articular manifestations.

00:01:55
Osteoarthritis is a local, non-systemic bone and articular cartilage condition, and manifests none of the features shown in figure 6.1 in your text.

00:02:08
The systemic nature of rheumatoid arthritis also accounts for constitutional complaints such as fatigue, low grade fever, and weight loss.

00:02:19
So the symptoms should help you differentiate between osteoarthritis and rheumatoid arthritis.

00:02:26
[BLANK_AUDIO]

00:02:29
Etiology of joint pain.

00:02:31
Understanding patient demographics is crucial in identifying the risk of joint diseases as age of symptom onset and sex may affect the likelihood of having any given condition.

00:02:45
Conditions like primary osteoarthritis, rheumatoid arthritis, and ankylosing spondylitis often have specific age and sex-related patterns of symptom onset.

00:02:54
Just like the last slide, paying attention to patient demographics and symptom patterns can give you a clue regarding differential diagnoses.

00:03:05
Factors may include family history, health history, and viral infections.

00:03:11
The presence of family history can be a significant risk factor, often seen in rheumatoid arthritis, ankylosing spondylitis, and systemic lupus erythematosus.

00:03:21
Health history is another critical component for a disease risk assessment, with lots of conditions tied to specific background risks, such as joint infection and autoimmune disorders.

00:03:32
Viral infections, sunlight exposure, and the use of certain medications can all contribute to systemic lupus erythematosus.

00:03:41
And this illustrates the complexity of health history as a risk determiner.

00:03:46
The patient's symptom description.

00:03:48
Important information can be learned just from a patient's description of their symptoms.

00:03:53
A mnemonic O.P.Q.R.S.T can help you organize your approach to a patient's chief complaint.

00:04:02
So a comprehensive examination of a patient's primary complaints involving details about the area and the nature of symptoms, the onset, aggravating and relieving factors, and daily pain variations can be crucial to informing your understanding of the patient's health status.

00:04:20
With common symptomatic patterns and assumptions underpinning therapy approaches.

00:04:26
So the mnemonic OPQRST symptom description, O is onset of symptoms,

and then P is provocation and palliative, Q is quality.

00:04:37
R is region and radiation, S is severity, and T is timing.

00:04:43
So with O, the approach to a patient interview often involves starting with open-ended questions, followed by questions with increasing focus.

00:04:53
The P is identifying what exacerbates or alleviate the patient's symptoms, and this can be very important for diagnosis and treatment.

00:05:01
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00:05:03
Q is requiring a detailed description of a patient's pain and a comprehensive 24-hour report because this can indicate specific conditions.

00:05:13
For example, gout is often characterized by a sudden onset and nighttime attacks while rheumatoid arthritis and ankylosing spondylitis often include extensive morning stiffness.

00:05:24
And osteoarthritis might involve mild to moderate morning stiffness that relieves within 30 minutes of activity.

00:05:32
But it could also present with nighttime discomfort.

00:05:36
R, identifying the specific affected area, right, the region and radiation.

00:05:42
Understanding the pattern of pain dispersion and the number of affected joints can really inform the cause of joint pain.

00:05:49
Determining joint anatomical location and understanding patterns of affected joints can help guide your identification of underlying causes of the joint pain.

00:06:00
For example, both osteoarthritis and rheumatoid arthritis commonly affects certain joints, like the hips and knees, but they exhibit very

different patterns and involvement of other areas.

00:06:12
S is severity.

00:06:14
So assessing a patient's subjective pain intensity at its worst and at its best and maybe even the current level, even though it's not diagnostic and can provide you with some critical information.

00:06:27
The timing, T, understanding whether the patient's status has been worsening, improving, or remaining consistent, can also provide you with very useful information as you're beginning to examine your patient.

00:06:41
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2.2 Physical Examination Limb Pain Dizziness

00:00:01
Okay, welcome to the next section, physical examination, limb pain, and dizziness.

00:00:06
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00:00:10
So our objectives for this section are to describe why identifying patterns and non joint related limb pain is critical for diagnosis.

00:00:18
Identify components critical to examining a patient complaining of dizziness.

00:00:23
Differentiate between central and peripheral causes of dizziness.

00:00:28
Define disequilibrium including contributing factors.

00:00:32
Describe symptoms, examination components, and potential causes of presyncope.

00:00:38
Describe symptoms and examples of nonspecific dizziness.

00:00:42
[BLANK_AUDIO]

00:00:45
Physical examination.

00:00:48
Comprehensive physical examination and observation can detect symptoms such as joint redness or swelling, potentially indicating a need for urgent physician referral.

00:00:58
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00:01:00
A thorough physical examination comprising system reviews and keen observation can underscore concerns raised during a patient history gathering.

00:01:10

Symptoms such as joint redness, warmth, and edema, particularly in the absence of major trauma, may necessitate urgent physician referral.

00:01:18
[BLANK_AUDIO]

00:01:21
Physical examination, limb pain.

00:01:24
Recognition to patterns and non-joint related limb pain is critical.

00:01:29
Etiology of limb pain, conditions such as hypothyroidism and Lyme disease, among others, cause limb pain and share symptoms with treatable conditions.

00:01:39
This necessitates in depth review of symptoms to ensure accurate diagnosis.

00:01:45
Hypothyroidism, Lyme disease, polymyalgia rheumatica, statin-induced myopathy all share these traits.

00:01:53
They're all systemic in nature.

00:01:55
They all generate musculoskeletal symptoms.

00:01:57
And they all generate non-specific symptoms.

00:02:01
[BLANK_AUDIO]

00:02:03
Bilateral lower limb complaints could indicate central or systemic issues, while shifting limb pain without a mechanical cause may suggest conditions not typically managed by physical therapists.

00:02:15
In which case the findings combined with their non mechanical symptoms
Could cause you to think about or consider an urgent physician referral.

00:02:25
Systemic origin.

00:02:26
All these conditions result from systemic dysfunctions, whether hormonal, infectious, immune related, or drug induced musculoskeletal symptoms, these conditions can cause widespread musculoskeletal discomfort.

00:02:41
Including limb pain, muscular weakness, stiffness or cramps.

00:02:46
Nonspecific symptoms, these conditions often present with generalized nonspecific symptoms like fatigue, weight changes, fever or malaise, requiring thorough diagnostic measures to differentiate and confirm.

00:03:00
[BLANK_AUDIO]

00:03:06
Dizziness.

00:03:08
Dizziness and vertigo are common complaints in medicine, especially in older populations.

00:03:14
A precise description of the dizziness, its timeline, and associated complaints are critical in identifying a diagnosis.

00:03:21
You should investigate balance and function.

00:03:24
Patient's past medical history, medications and lifestyle should all be considered.

00:03:30
Investigation into balance and function particularly after head and neck movements can reveal signs of dizziness such as cord compression or cervical arterial dysfunction.

00:03:40
With a lack of dizziness, not ruling out the possibility of cervical arterial dysfunction.

00:03:46
A patient's medical history, medications, and lifestyle should all be considered with auto toxic medications and environmental factors, neurologic red flags and information about prior medical examinations, living conditions, and functional status.

00:04:02
Playing pivotal roles in your evaluation process.

00:04:05
[BLANK_AUDIO]

00:04:10
Causes of dizziness, vertigo and peripheral vestibular disorders.

00:04:15
Vertigo is caused by asymmetric involvement of the vestibular system.

00:04:20
Peripheral causes of vertigo involve the inner ear and nerve.

00:04:24
Central causes originate in the brain, like multiple sclerosis, strokes, tumors, and migraines.

00:04:31
Vertigo is caused by asymmetric involvement of the vestibular system, which includes the inner ear, vestibular nerve, brainstem, cerebellum, and cortex.

00:04:41
Peripheral causes of vertigo involve the inner ear and nerve like benign paroxysmal positional vertigo BPPV, vestibular neuritis, menieres disease and acoustic neuroma.

00:04:54
Central causes of dizziness originate in the brain, like multiple sclerosis, strokes, tumors, and migraines.

00:05:01
Differentiating central from peripheral vertigo relies on associated symptoms and exam findings.

00:05:07
The quality of vertigo, presence of neurologic signs, and characteristics of nystagmus.

00:05:13
[BLANK_AUDIO]

00:05:18
The consequences, vertigo, peripheral vestibular disorders.

00:05:23
Central vertigo stems from the brain, causing severe imbalance, neurologic signs, less nausea and central misdiagnosis.

00:05:32
Multiple sclerosis, strokes, cranial vertebral disorders, and tumors can all cause central positional vertigo and his diagnosis.

00:05:41
Strokes affect circulation causing vertigo plus other neurologic signs like dysarthria and dysphagia.

00:05:48
Migraines are associated with episodic vertigo, especially in children, but the mechanism is unclear.

00:05:54
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00:06:01
Dizziness disequilibrium.

00:06:04
Disequilibrium refers to dizziness and imbalance without vertigo.

00:06:08
Often from dysfunction in the vestibular, somatosensory, and visual systems or central areas like the cerebellum.

00:06:15
Contributing factors include aging, neurologic disease, and biomechanical constraints.

00:06:23
It's assessed via posturography testing of the balanced triad somatosensory, vestibular, and visual inputs.

00:06:29
[BLANK_AUDIO]

00:06:34
Physical examination, dizziness, presyncope.

00:06:37
Presyncope is the feeling that you're about to faint.

00:06:40
So symptoms might include a feeling of light-headedness.

00:06:43
There's no illusion of motion like vertigo and there may be reduced cerebral blood flow.

00:06:49
Cardiovascular causes include structural heart disease, coronary artery disease, and arrhythmias.

00:06:54
Non-cardiovascular causes include orthostatic hypotension, hypoglycemia, hyperventilation, and possibly medications.

00:07:02
[BLANK_AUDIO]

00:07:08
These examination should include orthostatic vitals, Cardiac auscultation, ECG, and even tilt table testing.

00:07:16
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00:07:20
Physical examination nonspecific dizziness.

00:07:23
Psychiatric disorders like anxiety, panic, and phobias are associated with dizziness especially in social settings.

00:07:31
Depression as a cause is a little less clear.

00:07:35
Patients report subjective sensations like floating, rocking or internal spinning.

00:07:40
Phobic postural vertigo may result in dizziness and unsteadiness without objective findings.

00:07:46
Cervicogenic dizziness, involves dizziness associated with neck dysfunction like pain and decreased range of motion.

00:07:53
It may be seen with whiplash injuries or cervical degeneration.

00:07:57
Cervical genetic dizziness as a diagnosis of exclusion after ruling out other causes.

00:08:04
Tests like the smooth pursuit neck torsion test can differentiate it from other dizziness causes.

00:08:09
Treatment usually focuses on the underlying cervical disorder.

00:08:13
[BLANK_AUDIO]

2.3 Physical Examination Headache

00:00:00
Okay, welcome back to week 2, lecture number 3, physical examination, headache.

00:00:06
Objectives for this lecture include describe the etiology of cervicogenic, migraines, tension, cluster headaches, and giant cell arteritis.

00:00:16
Describe typical symptoms of a migraine headache.

00:00:20
Headaches are very common with a lifetime prevalence of over 90% in both men and women.

00:00:24
I'm sure most of you have experienced a headache.

00:00:28
There are frequent comorbidity seen in outpatient physical therapy and occupational therapy clinics, etiology of headaches, cervicogenic migraines, and cluster.

00:00:38
Cervicogenic headaches arise from neck tissues like facettes and muscles causing unilateral head pain starting in the neck.

00:00:45
Migraines are often unilateral but they can shift from side to side between attacks.

00:00:51
Tension headaches are bilateral and often described as a vise like band.

00:00:55
Cluster headaches come in severe unilateral pain clusters and they can last 15 minutes to three hours with autonomic features like tearing and congestion.

00:01:06
Provocation with neck movements helps diagnose cervicogenic headache.

00:01:11
Migraines may be associated with nausea.

00:01:14

Sensitivity to light or sound and throbbing pain that prevents formal activity.

00:01:19
Tension headaches may be associated with life stressors and are usually milder than migraines.

00:01:25
Continuing with etiology of headaches including arteritis migraines and continued tension headache discussion.

00:01:32
Giant cell arteritis causes new onset of temporal headache and jaw or neck pain.

00:01:37
It can result in vision changes, fever, and even weight loss may occur.

00:01:43
Migraines may present with or without aura, and may be preceded up to 48 hours by symptoms such as fatigue, altered mood, or changes in appetite.

00:01:52
They also can include prodromal symptoms.

00:01:56
Tension headaches lack the associated symptoms of migraines.

00:02:00
Giant cell arteritis is a vasculitis, eventually resulting in artery luminal occlusion.

00:02:07
The resultant vascular stenosis can cause permanent visual loss if the cranial arteries are involved and the inflammation can lead to aortic dissection.

00:02:17
Blood vessels typically involved include the medium and large vessels originating from the aortic arch.

00:02:23
The inflammation is likely to be segmental, skipping portions of the vessel.

00:02:29
The chief complaint will be a new onset of unilateral headache, often described as new or unfamiliar to the patient.

00:02:36
Pain will be localized to the temporal regions and the therapist may even observe a bulging vessel in this area.

00:02:43
Suspicion of giant cell arteritis should result in strong consideration of urgent referral.

00:02:49
The duration of migraine symptoms varies from a few to up to 72 hours in length.

00:02:56
Addressing the underlying life stressors may be important when treating things like tension headaches.

00:03:02
In summary, the literature documents cases where patients presenting to physical therapy were found to have serious undiagnosed pathology upon therapist examination.

00:03:13
And this underscores the need For the therapists to be familiar with red flags.

00:03:18
Providers must understand the key features distinguishing musculoskeletal conditions suitable for conservative therapy.

00:03:25
Versus those requiring urgent physician referral to ensure timely diagnosis and management.

00:03:32
So we've covered a framework for generating a broad differential based on symptoms that the clinician should refine using history and examination to determine the need for escalation of care.

00:03:43
The medical literature contains numerous case reports of patients presenting to physical therapy with common musculoskeletal complaints like arthrology of joint pain or dizziness.

00:03:53
Who were subsequently found to have a cold serious pathology upon examination by the therapist.

00:04:00
It's important for providers to be aware of the risk factors clinical

features and patterns of presentation that could distinguish musculoskeletal conditions.

00:04:09
That may be treated conservatively through physical therapy from those requiring urgent or emergent physician referral.

00:04:17
An understanding of red flag pathology is critical to ensure timely diagnosis and management of potentially life threatening disease processes.

00:04:26
This information presented here and in your textbook provides a framework for generating differential diagnoses based on the patient's reported symptoms.

00:04:35
The onus is then on the clinician to corroborate or refute elements of that differential based on a careful history taking and physical examination.

00:04:44
Any findings suggestive of serious pathology should prompt you to escalate care and immediately consult with the appropriate medical specialists.

00:04:53
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3.1 Principles of Radiology

Effects
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[MUSIC]

00:00:07
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00:00:09
So this is the first lecture, Principles of Radiology.

00:00:16
And in this lecture we'll be discussing general principles and radiology.

00:00:24
[BLANK_AUDIO]

00:00:27
So the objectives here are to describe why clinicians need to view diagnostic images.

00:00:34
Describe radiology and musculoskeletal imaging.

00:00:37
And then summarize the evolution of imaging From Wilhelm Rontgen in 1895 through today, so a lot of this first lecture is going to include some history.

00:00:48
[BLANK_AUDIO]

00:00:54
So why do we need diagnostic imaging?

00:00:59
Well, the PT education provides a foundation for understanding imaging and the PT education provides a foundation for being able to associate our clinical findings with findings on imaging.

00:01:15
[BLANK_AUDIO]

00:01:17
So if physicians already have access to ordering and interpreting imaging, then why would physical therapists need any kind of diagnostic imaging education?

00:01:30
Well as we just stated, PTs receive education in basic sciences like anatomy.

00:01:37
And we also have an education that's clinical, and we have an applied science education.

00:01:45
And so we should have the confidence and the tools to be able to communicate effectively with radiologists to get additional information from looking at images on their own.

00:01:58
So, imaging provides a more comprehensive evaluation.

00:02:03
And so, when you're examining a patient, that patient history and the physical findings can be supplemented by imaging.

00:02:11
When that's necessary to provide a more thorough understanding of any kind of underlying pathological process.

00:02:19
But it can also help illuminate maybe the absence of some sort of underlying process that you might have thought was going on but isn't.

00:02:30
And finally, a physical therapists could be looking for information from imaging.

00:02:37
That's not the same as the kind of information that a physician might be looking for.

00:02:42
So we can imagine a case where maybe there's a bony malunion and that may change our treatment goals and our interventions.

00:02:53
Know for example, what we may be able to expect in terms of range of motion.

00:02:57
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00:03:02
So what is radiology?

00:03:04
Well, radiology is investigating or exploring the use of radiant energy and where do you active materials to diagnose, treat and prevent disease?

00:03:18
So radiology is generally the term interchangeable with diagnostic imaging or medical imaging right.

00:03:26
So basically one can be substituted for the other without changing the meaning so these things are all essentially mean the same thing, right?

00:03:36
Findings from the radiology report.

00:03:38
Findings from diagnostic imaging, results of medical imaging, etc.

00:03:41
They all sort of convey the same idea.

00:03:43
[BLANK_AUDIO]

00:03:49
So what is musculoskeletal imaging?

00:03:55
That is an MSK right there.

00:03:59
That's a subspecialty of radiology.

00:04:01
Looking at the musculoskeletal system, so conventional radiography or X rays.

00:04:07
That's usually the first order imaging procedure after the clinical examination when we're looking for suspected musculoskeletal pathology.

00:04:16
So if a patient is suspected of having a fracture, it's very likely that the x-ray will be the first choice for imaging.

00:04:25
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00:04:29
So in 1895, Willem Roentgen, that's this gentleman right here I was working in his dark laboratory in Germany.

00:04:37
And he noticed that a screen that was painted with a fluorescent material and located a few feet away in the same room as a cathode ray tube started to glow.

00:04:50
So this screen somewhere over here, if this room was dark, is now glowing and after repeating the experiment.

00:04:58
He recognized that the screen was responding to the nearby production of a form of energy that was transmitted invisibly through the room from this cathode ray tube.

00:05:11
So here's this cathode ray tube imaginary one over here.

00:05:15
But it's transmitting this invisible energy over here to this screen.

00:05:21
And he named those rays x-rays using the mathematical symbol x,because x symbolizes something unknown.

00:05:30
And it didn't take very long before almost everyone was taking x rays of almost everything that they could think of.

00:05:36
[BLANK_AUDIO]

00:05:39
So x-rays were used to detect art forgeries and they were used in jewel smuggling, detecting jewel smuggling.creative entrepreneurs sold.

00:05:50
X-ray proof underwear and customers at shoe stores could have X-rays taken to the feet inside a new pair of shoes.

00:05:57
We can see here.

00:05:59
So this is illustrating some x-ray proof clothing here on this lady,

and by using the x-ray proof clothing.

00:06:09
Apparently, someone wielding an x-ray wouldn't be able to look at your bones, which I guess was important.

00:06:16
[BLANK_AUDIO]

00:06:21
So in the early 1900s, there was an X-ray craze.

00:06:25
The X-rays were seen as a miracle cure and they could do things like kill germs and improve beauty.

00:06:32
But exposure to radiation had consequences.

00:06:37
And by World War I, there was a very popular image of a radiologist, and that image included a gloved or an amputated hand, which was a result of that hand being exposed to x-rays, right?

00:06:52
But even as those x-rays became combined to medical settings, they're is still used and coin operated Foot-o-Scopes which were used for looking at feet all the way up until after World War Two.

00:07:06
And then in 1957 Pennsylvania became the first state to ban the use of those Foot-o-Scopes.

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00:07:14
We can see one of those over here Foot-o-Scope.

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00:07:24
So, in the 1910s and 20s, the military was using x-rays to screen for tuberculosis via chest x-rays.

00:07:33
The military was also using x-rays to examine bullet wounds and fractures.

00:07:39
And military was very active during that time, driving trucks with portable x-ray units.

00:07:47
And then we have the development of diagnostic ultrasound and that evolved from sonar technology.

00:07:55
And in the 1920s and 30s nuclear medicine development continued and still there wasn't much consideration given to radiation exposure.

00:08:05
And in fact, the average age of death around that time for a radiologist was about 56 years old, Marie curie's notebooks are still radioactive today.

00:08:16
So in 1945, the detonation of atomic bombs generated more interest in the effects of exposure to radiation.

00:08:25
And in the 50s and 60s, effective dose limits began to be talked about and what that meant was that there became this recognition that no dose exists below which the risk of damage does not exist.

00:08:40
So, the idea was to keep the dose as low as reasonably achievable right here ALARA as low as reasonably achievable.

00:08:55
So in the 1970s computer-heated tomography permitted cross-sectional images.

00:09:01
And a single slice of image took around 4.5 minutes of scanning and then 1.5 minutes of processing, today, it takes less than a second.

00:09:13
In 1984, MRI was approved for clinical use.

00:09:18
Right here, in the 1990s, functional MRI changed the way we can view the chemical composition of the brain.

00:09:30
And after that charged-coupled devices began to translate light to images, and we were able to convert film-based to digital imaging.

00:09:42

And then picture archiving and communication systems, PACS, allowed the storage and the viewing and filing and transmission of images so that.

00:09:52
A whole network of clinicians could have immediate access to an image.

00:09:57
Computer-assisted diagnostics and pattern recognitions

00:10:01
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00:10:04
Began to pick up, and those are still being developed today.

00:10:07
But humans are still better at identifying harmful non-normal kinds of images.

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But things like image-guided surgery continue to progress and surgical robotics, molecular imaging, PET-CT and PET MRI.

00:10:22
PET stands for positron emission.

00:10:25
In these kinds of developments enable more individualized approaches to different treatments.

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00:10:34
So medical images that were stored on film really have acquired an incredible amount of space for storage in a facility and in addition, a film could only be at one location at any time.

00:10:47
And so this meant that there were times when a film might be needed to help determine the care for a patient, but that film may not be available at that location.

00:10:57
So now studies are maintained on servers where images can be archive.

00:11:02
They can be transmitted or communicated to others, and they can be stored, and this system is called PACS, picture, archiving,

communications, and storage.

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3.2 Radiation

00:00:01
So Lecture 3.2, Radiology Equipment.

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00:00:09
The objectives for this lecture are to identify the three things required to produce an X-ray.

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And number two, describe the terms radiograph, image receptor, radiation, effective dose limits, and sievert.

00:00:27
So a radiograph is an X-ray film containing an image of part of a patient's anatomy.

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And producing a radiograph requires an X-ray source, a patient, and an X-ray film or an image receptor.

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So it's also referred to as plain film radiograph, standard radiograph, conventional radiograph, and most commonly now as films or X-rays.

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The standard medical literature language is radiographs.

00:01:00
Also, it's important to remember that hardcopy is film and softcopy is a digital copy of the image.

00:01:11
This slide on the right side over here shows a picture of radiant energy in the electromagnetic spectrum from lower frequency radio waves all the way up through higher frequency Gamma waves.

00:01:26
And radiology is the branch of medicine concerned with radiant energy and radioactive substances.

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And those include X-rays and radioactive isotopes along with ionizing radiation.

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And this also encompasses the application of this information to prevention, diagnosis, and treatment of diseases.

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Radiation is energy transmitted through space or matter.

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And the shorter the wavelength, the higher the energy of the radiation and the greater the penetrating power.

00:02:01
Physicians specializing in radiology are radiologists, and professional technicians who produce the images are radiographers.

00:02:12
Most imaging studies are produced by ionizing radiation, while diagnostic ultrasound and MRI are examples of non-ionizing imaging studies.

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So diagnostic imaging is the same thing as medical imaging and the same thing as radiology, they're basically interchangeable descriptions.

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00:02:36
What are X-rays?

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X-rays are ionizing electromagnetic radiation.

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And this is different than non-ionizing radiation like ultraviolet light, visible light, infrared, microwave, radio and TV radiation.

00:02:51
That does not have enough energy to remove electrons from atoms or molecules.

00:02:56
X-rays are ionizing electromagnetic radiation.

00:03:01
So again, some non-ionizing sources of electromagnetic fields include cell phones, tablets, radios, older TVs, power lines, electrical wiring, and home appliances.

00:03:14

And if we look at this picture here, we can see basically this span moving from non-ionizing radiation on the left, ionizing radiation on the right.

00:03:28
And ionizing radiation means that this radiation is going to have the potential to remove electrons from atoms or molecules.

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00:03:46
So non-ionizing radiation is low energy radiation that can cause molecules to vibrate and produce heat like microwave, ovens.

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Radio waves and visible light are other examples, and for most people, non-ionizing radiation does not pose a risk to their health.

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00:04:12
The sievert or millisievert is a measure to quantify radiation and measure its impact on people.

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In high doses, Ionizing radiation can damage cells or organs or even cause death by detaching electrons from atoms or molecules.

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Which involves the production of ions, and hence the term ionizing radiation.

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Inappropriate doses used in medical diagnosis and treatment of diseases, ionizing radiation can be helpful, for example combating diseases such as cancer.

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00:04:53
There are no prescribed limits on radiation doses to patients.

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This means that no amount of radiation is considered too much for a patient when the procedure is justified by the health care provider after considering the benefits and the risks.

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And examination that serves no purpose is inappropriate, no matter how small the radiation dose.

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Ensuring that the results of earlier imaging are available helps avoid unnecessary exposure to radiation through repeat investigations.

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And so one of the things to note here, is the natural exposure to radiation, for example from the air or from traveling in an airplane.

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And compare that to the magnitude of radiation exposure and, for example, a single chest X-ray which is relatively small.

00:05:43
And a chest CT scan, a single scan which is orders of magnitude larger in terms of radiation exposure.

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So this term over here, ALARA, stands for As Low As Reasonably Achievable.

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And I included this slide to provide additional examples of radiation exposure.

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And so we can see the naturally occurring yearly exposure here is 3 milli sieverts and average US background radiation is 3.6.

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Again, we compare that to a chest CT here of 5 to 8, and compare that again to an abdominal CT 5 to 10 millisieverts.

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So a CT of the abdomen with a dose of 10 millisieverts is approximately equivalent to 500 chest X-rays, or three years of average US background radiation.

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3.3 Production of XRAYS

00:00:02
Welcome to lecture 3.3, and this lecture is The Production of X-Rays.

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The objectives of this lecture are to describe how x-rays are produced.

00:00:19
Describe radio density and how it is depicted in a radiograph, describe the effect of thickness and orientation on a radiograph, and identify four factors that impact image quality.

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How are x-rays produced?

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So to produce x-rays we have to have a source of electrons, and then we have to have a force to move them.

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And finally you have to have something to stop the movement of those electrons quickly, and so that leads us right into our next slide.

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00:01:04
So, we have an x-ray tube over here and we have the x-rays traveling here and we have the image receptor right here.

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The x-rays are produced in the tube and they travel out and pass through the patient.

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Where they're attenuated to different degrees depending on the tissue that those electrons pass through.

00:01:31

The x-ray beam that emerges from the other side of the patient called the remnant radiation is intercepted by an image receptor.

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The information that the receptor is processed by different methods depending on the type of receptor and following that an image is produced, which is called a radiograph.

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Understanding the Image, radio density is determined by the composition and thickness of an object.

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And radio density affects the amount of radiation an object absorbs from the X ray.

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Radioopaque means that an object is not easily penetrated by x-rays.

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The representation of the object is white because x-rays do not reach the receptor.

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Examples include things like heavy metals or fillings and teeth, or contrast media such as barium sulfate.

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Radiolucent material is easily penetrated by x-rays.

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Most of the x-rays will reach the receptors so the radio graphic representation of the object is dark, air is an example.

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When describing bone, radio loosen areas have decreased radio density due to abnormal processes such as osteoporotic bone or osteolytic tumors or infections.

00:03:00
And in this image on the top right here we can see that objects that are more radiolucent are near the top such as air.

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And objects that are more radio-dense are near the bottom, such as metal.

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Thickness and orientation of an object will also affect the image.

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Radiographic density as a function of thickness of the object will vary.

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So pretend the objects being radiographed are a series of bone slices, each progressively thicker in a stepwise fashion.

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Now look at the developed image, it also has a stepwise increase in lighter shades Gray.

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00:04:03
The finished slice of bone on the left image is the least radio dense and the thickest slice on the far right is the most radio dense.

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The point here is that the thicker any object is, the greater amount of radiation it will absorb compared to a thinner object or a thinner portion of the same object.

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Now, if we look at images A through F over here.

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This is a wedge of wood radiographed from three different angles and it produces three distinctly different radiographic shape outlines.

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With varying radiographic densities depending on how much thickness of wood the beam passes through

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00:04:59
This effect is seen also in the bottom right here with this tube.

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For a radiograph to be useful, more than one projection is required.

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A single image only provides information in two dimensions, length and width.

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So that third dimension depth is achieved through a second radiograph performed at a 90 degree angle to the first one.

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Two images taken at right angles to each other provide information on length, width, and depth.

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And we can see that over here with this image of a finger

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This slide is also meant to discuss the importance of having multiple images.

00:05:54
For A over here, the lateral projection of the cervical spine best demonstrates the facet joints indicated by the point of the pen.

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So you can find the facet joint on the corresponding lateral radiograph on C right here.

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The facet joint space images as a dark diagonal line or arrow.

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Again, that dark diagonal line is dark because it's not as dense as the bone.

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In B,

00:06:28
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The oblique projection of the cervical spine best demonstrates the intervertebral foramina.

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The tip of the pen is at the C5-6 right intervertebral foramen, look at the corresponding radiograph in D.

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00:06:47
The intervertebral forum in images as a dark oval, and that's right here.

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Again, it's dark because it's less dense than the surrounding tissue and bone.

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00:07:02
So we have a two radiograph minimum, when you want to use these radiographs to provide information about the dimension of the structure and so that requires to radiographs.

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This will also allow us to locate lesions or foreign bodies and determine alignment of fractures.

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So the most common projections for the skeleton are the AP, lateral and oblique projections.

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Oblique projections may be included during joint examinations or examinations where the surface topography is more complex.

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So this slide apparently needs a slide title, we'll call it The 4.

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Major radio densities.

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And those are depicted in this image and in number 1 over here.

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Air can be seen in the descending colon and also in the center of the pelvis, and this is the typical speckled look of feces mixed with gas right there.

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If we look at number 2, this is fat seen as this sort of dark streak either side there.

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And that's fatty layer next to the peritoneum and the abdominal wall and that stripe is the fold of the fat layer as it turns posteriorly towards the patient's back.

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Now in number 3 over here, what we can see is water and muscles and soft tissue share the same density as water.

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And many water density organs, vessels, and muscles comprise the shades of gray in this radiograph.

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The arrow points to the so as muscle as it extends along the border of the lumbar spine.

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So right in here.

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00:09:16
And then number 4 is bone, and we can see the bony components of the proximal femur and the pelvis and sacrum and the spine.

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And this picture, we can really see how radio dense or bright bone is.

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So this slide depicts media and heavy metals in imaging.

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And if we look over here first on the left, The lower GI dual contrast medium examination is depicted here.

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And this normal colon is coated inside with barium and extended with air and so that's what the dual refers to, the barium and the air.

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The bright white outline caused by the medium allows detailed visualization of the structures, which wouldn't normally be visible on plain radiographs.

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And the image on the right here, this is a total hip replacement or a total hip arthroplasty.

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The metals used in the prosthetic of this joint, they absorb the x-rays and cast a solid white image on the radiograph, very radio dense.

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So any anatomic structures behind the metal or the prosthesis are obscured.

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So in this slide we'll go over some terms for patient positioning and x-ray projection.

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So the position is how the patient is placed during the radiographic exam, and examples include supine, prone, sideline, recumbent, those are standard.

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We also have erect or weight bearing, and that indicates that the joints are under the effect of gravity, or under load.

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The projection is what direction the x-ray travels in in relation to the patient's body and so we have anterior posterior oblique and lateral

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So these are some examples of oblique views.

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And when these images are viewed, they can either be done in light boxes or digitally using a monitor.

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And the image is usually viewed with the image in the anatomical position.

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In other words, if you have an anterior posterior image of the knee, you want to have the image position so that it looks like the patient is standing in front of you.

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So in this slide we'll talk about some basic radiographic terminology again.

00:12:00
So position identifies the patient's position in two ways, in reference to the general body position and in reference to specific positions describing which body part is closest to the image receptor.

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Decubitus, here the patient may be lying prone supine all on one side.

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Usually these positions are used to detect air fluid levels in the chest and abdomen.

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Radiographs can be made with the patient upright and [UNKNOWN] in standing position.

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And rectal wing bearing/u can establish that joints were gravity and

or wing bearing/u independent.

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And usually if a joint is wing bearing, this is marked on the radiograph.

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00:12:48
And so in position starting with A, right, we have general positions including upright, seated, supine, prone, erect, recumbent and Trendelenburg.

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And then specific describing which body part is closest to the image receptor as I mentioned earlier, and then decubitus is basically our lying positions.

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For more on this you can see table 1.5 and figure 1.16 in your McKinnis text.

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So as I mentioned earlier, it's important to always view the radiographs as if viewing the patient and the anatomic position, right?

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So the radiographs are viewed as if the patient we're standing right in front of the viewer, in the anatomic position.

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This AP radiograph of the knee is being viewed properly.

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The R marker and we can see that right here, tells us this is the patient's right leg.

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So the radiograph is viewed with the fibula to the viewer's left hand side.

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The small letters below the R are the technician's initials.

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The pathology indicated in the circle is an osteogenic sarcoma.

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00:14:17
Image quality, density is the amount of blackening on an image, and contrast is the difference between the adjacent image densities.

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Detail refers to the geometric sharpness or the accuracy of the lines on the radiograph for example the resolution, the definition or the sharpness.

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Distortion refers to the difference between the actual object and the recorded images.

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So density and contrast are photographic properties that control visibility, detail and distortion are geometric properties that control clarity.

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3.4 Practice Acts and Deciding Whether to Image

00:00:01
Hi, and welcome to lecture 3.4.

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This is an introduction to practice acts and deciding whether or not to image.

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So our objectives here are to describe state practice regulation, with specific regard to how the scope of practice is regulated both geographically and legislatively.

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Provide two reasons why a physical therapist might request imaging.

00:00:27
Define the American College of Rheumatology, the ACR, Appropriateness Criteria.

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And describe how the x-rays interact with the patient, and the advantages and disadvantages of x-ray film versus digital imaging technologies.

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Referring patients for imaging.

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So the legal scope of practice in terms of referring patients is regulated by each United States jurisdiction through PT practice acts.

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And I have links on here to the APTA federal special interest group and the Academy of Orthopedic Physical Therapy special interest group for imaging.

00:01:11
In Australia, the United Kingdom, a portion of Canadian provinces and Norway, physical therapists have imaging referral privileges and imaging is standard within physical therapy practice.

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Colorado, Utah, Wisconsin, North Dakota, Rhode Island, Washington DC, New Jersey, Maryland and Arizona are states that expressly allow physical therapy imaging referral.

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There are a growing number of areas of the United States that are gaining referral privileges.

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Practice acts approach referral for imaging privileges with language that's categorized as specifically inclusive, interpretable to allow referral, silent, or specifically exclusive.

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Wisconsin and Utah, for example, allow PTs to refer for imaging.

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Colorado, Maryland, and Washington DC have some degree of freedom to refer for imaging and interpretations of their practice x.

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However, practice x of other disciplines, radiology technicians, for example, may limit who the provider can take orders from

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So what that means is that for radiology technicians, the practice act for that discipline may be prescriptive or prohibitive related to whom they can take their orders from.

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Thus, potentially affecting physical therapist's ability to refer for imaging.

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So why would we refer for imaging in the first place?

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Well, first to obtain a more comprehensive evaluation, to see the processes of growth or development or healing, disease or dysfunction.

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We can integrate imaging with the patient history and other lab or medical data, along with the physical examination, to provide a more complete set of information to base patient care decisions on.

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Essentially, we would be able to enhance the efficiency and effectiveness of care delivery.

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Over-utilization is a long-standing problem in referring for imaging.

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In this study of 2,051 lumbar spine MRIs ordered by general practitioners, 75% of those studies were deemed inappropriate.

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The majority of these referrals did not meet the American College of Radiology Appropriateness Criteria for imaging a patient with low back pain.

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So what is ACR?

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American College of, not Rheumatology, this is not correct, the American College of Radiology.

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00:04:08
American College of Radiology Appropriateness Criteria, ACR, AC for Appropriateness Criteria.

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So this information helps with assisting in making the most appropriate imaging or treatment decision.

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In the US, the American College of Radiology Appropriateness Criteria is considered the gold standard decision making guideline.

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Which imaging modality is recommended for a suspected diagnosis, for example, you would turn to the ACR Appropriateness Criteria.

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The goal of the ACR Appropriateness Criteria is to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.

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In addition, the ACR is intended to allow providers enhanced quality of care and to contribute to the efficacious use of radiology.

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So the American College of Rheumatology Appropriateness Criteria is an incredibly useful and important component of decision making in imaging.

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Factors for decision making according to the ACR Appropriateness Criteria include age, the presence or absence of trauma and mechanism of injury, prior surgery, pain provocation.

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And then there are also individual risk factors, such as physical appearance, neurologic status, other imaging results, weight-bearing ability and tenderness to palpation.

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So for example, how old is the patient?

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Under age, an 85-year-old patient with shoulder pain that has been worsening over time suggests differential diagnoses that are different from a 14-year-old with similar symptoms and progression of pain and loss of function.

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In terms of trauma, presence or absence, when the patient presents, was the injury a result of trauma?

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Was the mechanism of injury one that might suggest underlying pathology?

00:06:21
For example, the patient was reaching for a bag and felt a pop versus the patient reports waking up with shoulder discomfort.

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Is there a history of prior surgery?

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If this patient with shoulder pain has a recent history of full thickness rotator cuff repair, then your differential diagnosis might include a failure of that repair.

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And finally, physical examination and functional test results.

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So we can imagine a patient presents to you in the clinic with right shoulder pain.

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And the pain began a couple of weeks ago, and they cannot recall a specific inciting event.

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Basically, they don't remember doing anything to cause their shoulder to hurt.

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And so that's what we're looking at here, is a clinical condition, shoulder pain, a traumatic.

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So an example of applying the ACR appropriateness scale to a patient who presents with shoulder pain that was not the result of trauma.

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In this table, if your patient's shoulder disorder was severe enough that it limited their function and after a history and physical examination, you might then refer them for x-ray if you suspect a fracture.

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If, however, you suspect that bony integrity is maintained, right, that you don't suspect a fracture, and instead that the diagnosis is likely a disruption of the soft tissue of the rotator cuff.

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For example, your patient cannot lift their extremity or strength testing reveals marked deficits that cannot be explained by guarding, that is, instead of an x-ray, an MRI would be the most appropriate imaging modality.

00:08:00
In this case, at least in Arizona, you would need to refer the patient to their referring provider, along with the suggestion to consider MRI to rule out a meaningful rotator cuff disorder.

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I included this slide here because one of the themes that will recur consistently throughout this course is that you must decide whether to treat the patient, to refer the patient out immediately, or to treat the patient and refer them out.

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00:08:35
So, if you decide to treat, you're deciding that the patient's condition is within the scope of PT practice.

00:08:42
If you're deciding to refer the patient, you've decided that the patient's condition warrants referral to another provider.

00:08:50
If you're deciding to treat and refer, this means management of a portion of this patient's presentation is within the scope of PT practice.

00:08:58
However, the patient may need or benefit from the services of another provider.

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And it may be for the same condition or a condition that's occurring along with this one but is different.

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00:09:17
When you're considering referring a patient for imaging, one of the things to keep in mind is the financial implications.

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And looking at this table, we can see that, first of all, conventional radiographs, we can imagine around $450.

00:09:34
A CT scan, $2,000, MRI, $3,500, bone scan, $1,400.

00:09:41
In addition to the financial obligations, there's also the average radiation dose.

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And so, here we can see an x-ray is about 1.5, and we've gone over this before.

00:09:54
A bone scan of the whole skeleton here is 6.3 millisieverts.

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00:10:05
In addition, as you're considering whether or not to refer a patient for imaging, remember that you should rarely perform imaging as an exploratory tool.

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You should have an idea of what the imaging will show, and you should anticipate a course of action based on predicted imaging results.

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So what this means is that you should have formed a hypothesis regarding what you think is going on first.

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And you should have some idea of what you'll do if your hypothesis proves to be correct.

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And also, what you'll do if your hypothesis is not correct.

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So as you consider whether or not to refer your patient for imaging, you should reflect on whether the imaging will contribute to a change in your diagnosis or treatment.

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And a thorough patient examination will help you make appropriate imaging decisions.

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The history and physical examination are necessary to assist in deciding whether imaging is needed and what type of imaging would be most useful.

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Prudent use of imaging is informed by a really sound patient examination.

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If imaging confirms what is anticipated based on all prior information collected by you and the course of care is routinely managed by physical therapists, then imaging results will not contribute much to your initial plan of care.

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Consider a scenario where a patient is not progressing as expected or their condition is worsening, or consider a case where you're concerned about some serious underlying pathology.

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A patient with anterior hip inguinal and medial thigh pain, which is aggravated by walking, presents to you in the clinic.

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This patient also has a 20-year history of taking corticosteroids, and because of this, the patient's risk for osteonecrosis of the femoral head is elevated.

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After thoroughly considering the patient's history and physical examination findings, imaging may be warranted prior to proceeding with physical therapy treatment.

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If the patient did not have a long history of continuous corticosteroid use, then imaging may not be warranted.

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And so what we're looking at here is a avascular necrosis of the femoral head.

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3.5 Prescribing Imaging

Effects
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Hi, so welcome to lecture 3.5 on prescribing imaging.

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So in this lecture, we'll identify three considerations when deciding whether to refer a patient for imaging.

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We'll describe the appropriate imaging components of a request for imaging.

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We'll identify three negative consequences of imaging.

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And finally, we'll discuss how imaging results should be interpreted and communicated.

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So when we're referring the patient for imaging, a few things that we need to ask are, do we need additional information to help make a diagnosis, or a more comprehensive evaluation?

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And then, how severe do you believe the underlying condition could be?

00:00:56
And finally, what's the urgency of the referral, right?

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Do you believe that there's a potential for the underlying condition to become incredibly severe over the next 24 hours?

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Or do you think it's something that the patient might be able to wait to go see their physician until the next day?

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So essentially, imaging can provide additional information, really, a more comprehensive evaluation.

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And that really means that the success of rehabilitation depends on the effectiveness of your evaluation.

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And so the more thorough your evaluation, some more information you have on which to build your rehab program.

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So, many of your tools, the observation, the palpation, manual muscle testing, physical performance testing, etc, those are dependent on your own perceptive skills.

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And those have some degree of subjectivity and bias and limitation.

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And imaging can provide an objective visual aspect to the evaluation that makes the expertise of the clinician a little more comprehensive.

00:02:03
So supplementing your evaluation and your re-evaluation with images can increase your awareness of the patient in a different dimension.

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So your knowledge of functional anatomy essentially becomes more dynamically effective because you're able to directly visualize the processes of bone growth and healing, disease and dysfunction, related to findings that are seen on imaging.

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So the information that you seek is often of a different nature from the information that a physician seeks, and a different nature than what might be described in the radiologist report.

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So, for example, a physician needs to know whether a fracture of the distal radius that has united with a malunion deformity is clinically stable.

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And if so, then the cast can be removed and the patient can be sent for rehab.

00:03:01
On the other hand, you also need to know the severity and the configuration of the malunion deformity.

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And so looking at the radiographs, you can become a little more aware of how the joints of the hand, wrist, and forearm, or maybe the elbow have the potential to be affected by the deformity, right?

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So you can imagine a bony deformity heals in a way that, for example, in the elbow could limit terminal extension.

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And so you could be trying to stretch a person into terminal extension when that range is limited by a bony block that's obviously not going to stretch.

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So referring the patient for imaging, communication with the radiologist or the imaging service before and after the imaging procedure is critical in achieving optimal patient care with continuity.

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So that means the idea isn't simply to refer your patient out for imaging and then see what happens.

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It's really going to be incumbent upon you as therapists to make sure that you follow up with the imaging specialist.

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And so in the APTA standards of practice for physical therapy, it states that a physical therapy service collaborates with all disciplines as appropriate.

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And the physical therapist must refer patients, clients, to the referring practitioner or other health care practitioners if symptoms are present for which physical therapy is contraindicated or are indicative of conditions for which treatment is outside the scope of his or her knowledge.

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So, really, it's on you to recognize when you might be dealing with something that you're unfamiliar with in a way that you believe warrants additional information outside the scope of physical therapy practice.

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So, when you request imaging in a referral, your request should include relevant clinical information, a working diagnosis, pertinent clinical signs and symptoms, and also a specific question to be answered.

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And the American College of Radiology encourages that the request for imaging, quote, should provide sufficient information to demonstrate the medical necessity of the examination, and allow for its proper performance and interpretation unquote.

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And so that means two things, really.

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One is that you really should only refer those patients who you believe are going to have a high likelihood of benefiting in terms of their outcomes from that imaging.

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And you should include information that's going to allow the radiologist to use the appropriate imaging modality and the appropriate views to get information that's going to be meaningful for the patient.

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So, the American College of Rheumatology also states that the referral for imaging should include relevant clinical information on working diagnosis and or pertinent clinical signs and symptoms.

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And of particular relevance to the importance of a thorough history and physical examination, the referral should contain a specific question to be answered.

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And complete communication with the imaging referral really helps tailor, like I said before, the most appropriate imaging study for that patient and enhances the usefulness of the imaging report.

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So rather than simply requesting an x-ray of a patient's elbow, providing information such as suspicion of radial head fracture based on whatever the patient's medical history is, and based on your physical test and measures results, which you would also include in the report.

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That information can assist in the selection process of the imaging modality and the radiographic views.

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And so, the imaging is really going to be enhanced with the radiologist being better informed by you of the suspected specific anatomy that you'd like them to look at.

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So improving the availability of the clinical history and other relevant patient information has been cited in a number of different studies as a measure for improving the diagnostic process.

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And you can also provide your patients with an explanation of tests that you're ordering and why you're ordering them.

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And you can explain to them the purpose of the test and maybe what you expect to find, and how your treatment plan may change, or their expectations may change, based on the imaging results.

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Also make sure when you do describe your concerns in a letter to your referral source, that you describe them in a succinct approach.

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And that you explain that the symptoms aren't consistent with what you would expect.

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Or that those symptoms may be inconsistent with some group of words that might be useful, like inconsistent with musculoskeletal pathology, or inconsistent with neuromusculoskeletal pathology, etc.

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But something to sort of hint that additional medical specialization may be needed in order to uncover whatever is actually going on.

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00:09:07
What about the negative consequences of imaging?

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These are things that you also need to weigh as you decide whether or not to refer that patient back for additional medical evaluation.

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One is the idea of medicalization.

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And this means a negative impact on the patient's psychosocial status, possible negative impact on outcomes related to their medical condition as a result of additional medical studies.

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So we know that low back pain imaging research consistently shows a delay in return to work and lower functional outcomes versus no imaging for the same patients.

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Second, exposure to ionizing radiation.

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So you have to monitor over time the cumulative doses or dosage of ionizing radiation, because that effect is cumulative.

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And finally, a negative consequence of imaging is the potential costs.

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So, back in the day, for me, it's oh, 2005, 2006, I worked with a group of surgeons, and we had an MRI machine in the office.

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And at that time, an MRI typically cost around $1,500 to $1,700.

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And so you can imagine co-pays, or even those cases where a patient may not have insurance to cover the cost of imaging, that's a really important factor to consider as you decide whether or not to refer that patient.

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It's not the most important factor, right?

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Obviously the most important factor is going to be the patient's health and long-term, functional outcome, and ability to return to their usual kinds of life activities.

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But cost is something that really needs to be considered.

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Interpretation and communication of the imaging results.

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So your patient has come back and they have their imaging, and the imaging is in their electronic medical record and you can see those images.

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So the question becomes, do you then look at the images and provide a diagnosis to that patient, right?

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So the patient hasn't received the diagnosis from the radiologist yet.

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And so, medically and legally, the interpretation of the images is the purview of the radiologist.

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But PTs, by virtue of their education, training and experience should be able to recognize and understand normal anatomy, including the anatomy associated with usual lifespan changes, or anatomic variance, and then contrast that to abnormal anatomy.

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But the comprehensive interpretation and description of that anatomy is outside of the current scope of PT practice.

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Which essentially means that it's probably not a great idea if you have those imaging findings and you don't have a radiologist interpretation along with those findings, all you have is the imaging, to use that imaging to provide a diagnosis to that patient.

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That is outside of your scope of practice, medically and legally.

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That you really need to wait for the radiologist to interpret the imaging study.

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So you have to recognize and maintain the practice boundaries regarding interpreting medical imaging.

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And so, once you have that interpretation from the radiologist, this allows for educating the patient regarding their imaging results.

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Including what those results mean and the context of each patient's age, gender, and lifestyle, and symptoms, etc.

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And the physical therapists can also provide reassurance, such as helpful contextual information to the patient to improve the understanding of their imaging results.

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And that leads to a better informed patient without the potentially negative influences associated with the imaging results, right, or medicalization.

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And so that's where it's really important for you to be able to look at an image and at least have some idea of what's going on in that image, right?

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In this case, you're not providing a diagnosis, but by going over what you see in the image and incorporating that with the radiologist's interpretation of the image, the patient can then become better informed and more comfortable with what's being seen in that image or the information contained in that image.

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So routine radiographic examination results can be positive for the suspected diagnosis, negative for the suspected diagnosis.

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Negative for one diagnosis, but raising suspicion for another diagnosis.

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Or they could be inconclusive and you could require additional imaging to confirm or rule out the suspected diagnosis.

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And that could actually be mentioned by the radiologist in their follow up.

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And another possible alternative here is that your initial suspicion was wrong.

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So, in this case, the images are negative for the pathologic changes that you suspected, but the patient still does not improve with physical therapy.

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And so the imaging is performed again one month later, demonstrating a stress fracture, for example, at the talar neck, and the patient is referred for surgery.

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So what I'm kind of getting it, there is that you may have a patient who has some pathology that is present.

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But it's present in a way that's not been picked up by the imaging, and over time the size or the intensity of that pathology grows.

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So, in this example, the fracture size grows and a month later it's large enough that it actually does show up on the imaging.

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So, you could imagine a patient comes to see you at the clinic and they say that they stepped on the fold of a towel getting out of the shower, resulting in severe pain along the bottom and outside of their foot.

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And then after completing this patient's history and physical examination, you're worried that maybe they sustained a fracture to their fifth metatarsal.

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So after talking about this with your patient, you refer the patient for a radiographic examination to rule out that fracture the fifth metatarsal.

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So, once the patient receives radiographic examination and the results are interpreted by a radiologist, those results are going to include one of the following things that we mentioned before, right?

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Positive for the suspected diagnosis, negative for one diagnosis, but now there's a suspicion of something else, inconclusive.

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And then potentially wrong initial suspicion.

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So when you're speaking with your patient about your imaging results, explain to your patient the results that are relevant to them.

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You don't need to explain everything you know about imaging and attempt to impress them.

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And in this slide, I have a little tiny quote that says, you shouldn't tell an audience everything you know.

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That was an effort to impress them.

00:17:00
Instead, you should tell them what they need to know.

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And that's an effort to teach them.

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And so your goal is to take something that's potentially scary or intimidating and translate it in a way for that patient that allows them to understand the information.

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And if you do it really well, it allows the patient to become more comfortable with the material contained in that imaging.

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And more willing to sort of move forward with whatever treatment you decide it's going to be appropriate.

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So the PT should know when to order diagnostic imaging and how to communicate effectively with the radiologist.

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And the PT may not have the primary responsibility to interpret the images, but you should be able to identify and manage clinically relevant findings.

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And to be effective, you have to establish lines of communication with the radiologist, with the patient, front office staff, and you have to build relationships with radiologists and other specialists.

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So the communication between the physical therapist and the radiologist may be required to determine the next steps after imaging.

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So, think about scheduling a follow-up visit for your patient as soon as possible after the results of an imaging study are available, or communicate those results by telephone.

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3.6 Imaging Studies

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Hi, and welcome to this lecture on imaging studies.

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So the objectives of this lecture are, to describe some kinds of musculoskeletal imaging studies, that there are lots of clients with this particular lecture will include.

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Arthrography, myelography, conventional tomography, computed tomography, nuclear imaging, bone scintigraphy, magnetic resonance imaging, MRI, and ultrasonography.

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And then we'll also describe the functional view imaging.

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So, lots of stuff here.

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So other common musculoskeletal imaging studies, contrast enhanced radiographs or arthrography.

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So that's where we inject, a contrast substance, into a joint and the injected material distends the joint capsule and the internal tissues.

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So the synovium and the ligaments and the articular cartilage and the joint capsule abnormalities can all be imaged using this technique.

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So if we look at the top image here A, that's a negative contrast study of the knee.

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And you can note the full extent of the capsule here, as it's distended by the contrast, that's what these little white dashes are, right?

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You can imagine that that thing kind of filling up with that fluid,

and then down to here at B, this is a shoulder arthrogram.

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And so after injection of contrast into the glenohumeral joint.

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There's a filling of the sub acromial and sub deltoid bursa complex here indicating a rotator cuff tear.

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Then down and see this bottom image this is a corneal CT arthrogram of the wrist and it demonstrates leak of contrast with a radiocarpal joint through a tear and the scapula lunate ligament.

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So here we see the contrast right there.

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| And so this is a finding that you wouldn't be able to see on just an X-ray of the wrist.

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And so that's why these Contrast enhanced radiographs are [UNKNOWN] arthography can be extremely useful.

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So other common musculoskeletal imaging studies include myelography, and that's contrast enhanced radiographs.

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Of the spinal cord, the nerve root, or the dura mater.

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And, so if we look at these images here this is A, and this is B here.

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A and B are anterior posterior and lateral views made after injection of contrast into the fecal sac.

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And this conventional biogram can identify where the flow of contrast is restricted, but it can't identify the reason for the restriction, right?

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So this is an X-ray.

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And so we can see the contrast material here in A.

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I could see it here and be here, down here, but there's a space here.

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And so from the radiograph, we can see that something's going on.

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There's a space, and it's not continuous that flow of contrast material, right?

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It doesn't flow continuously from here, all the way down, something's interrupting that flow.

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Now we compare these with our CT myelogram down here right again, this is X-ray radiography and this is a CT.

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So we compare this with our with our CT myelogram and C is a coronal reformatted image and D is a sagittal reformat.

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And there's normal contrast filling the fecal space at all areas except at L1.

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And so when we look up here at L1, there's a bony defect that impinges on the fecal sac and indents the column of contrast.

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And so that, if we look at image D right here that's occurring right here.

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So we can see this is really bright area because see how it's coming into the fecal sac, boy I really messed that up there we go.

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So you can see that now hopefully.

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And we can also look at C, and we can see here that we have contrast coming down here.

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And then there's a broken area.

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Okay, so the CT gives us a little more information than just the radiography.

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And so the other thing that I think is important here is that you can actually see the conus medullaris of the spinal cord and the star right here.

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And then, down here you can actually see the Cotter going down there.

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So the advantage of the CT is the direct visualization of the soft tissues, and you can actually see the cause of the impingement, right?

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We can actually see this area right here.

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And if we look up here, all we can see is that, there's something going on so with with the Radiography essentially the take home I think here is with the radio radiography.

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We get sort of a general idea that yes, something's wrong.

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And with the CT, we can actually see okay, there's something going wrong and it looks like it's occurring here at L one.

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So, another common musculoskeletal imaging study is tomography and conventional tomography or body section radiography.

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Conventional tomography is the radiographic evaluation of one plane of the body.

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And the depth can be modified by adjusting the equipment a little bit.

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And the principle of dimensional tomography is that you have an X-ray tube and the film moves in an opposite direction from the X-ray tube.

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Right, so, here we have our X-ray tube up here.

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Here we have our film down here and they move in opposite directions.

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The focal point, which is right here, that open circle remains in sharp focus while the other planes of the body, the dark circles become blurred by the motion.

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So imaging different depths of bone can allow a better understanding of the extent of a fracture, give you a little more information about it.

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And the evaluation of bony tumors can also be aided by conventional tomography.

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So, as opposed to conventional tomography, this is computed tomography, and what it does is it merges images from X-rays using a computer.

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Which reconstructs an axial cross-sectional slice of an image.

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And then processing can also reconstruct the data obtained in one plane and resolve it into multiple other planes.

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So, for example, data obtained in the axial plane can be resolved into sagittal, coronal, and even three-dimensional images like we see here.

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00:08:01
And so, this oblique view of the wrist demonstrates a fracture through

the waist of the scaphoid bone that's been complicated by avascular necrosis of the proximal fragment.

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So, we see here an S right here, this fracture,

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And one there.

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And then the avascular necrosis down here.

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And so tumors of bone and soft tissue, fractures, joint abnormalities, bone fragments, and metabolic bone disorders can all benefit from the use of Computed Tomography

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So nuclear imaging, nuclear imaging uses radiopharmaceuticals or radioactive tracers to diagnose based on the physiological or the functional changes of the tissue or organ.

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And so, the pharma side targets a particular organ while the radionuclide emits gamma rays.

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And the tracers are absorbed by the target organ in varying amounts based on the level of metabolic activity in the tissue.

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So, in this image here, a 16-year-old girl is diagnosed with lymphoma and sent for PET/CT scan before starting chemotherapy.

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And you can see how the metabolic data from the PET scan and the anatomic data from the CT scan are combined.

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So, here's the PET scan right here, and here's the CT scan and we combine the two.

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To get this the pet CT scan and the tumor uses the tracer as fuel, and so it ends up lighting up with increased uptake.

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And that seen in the right upper region of the chest.

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And, apparently, after six months of chemotherapy, a repeat scan showed a significant reduction of the tumor, indicating that the treatment was successful.

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But I think the important takeaway here is understanding that you're taking the image qualities of the PET scan here, combining them with the CT scan, to produce this image here.

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So this is extremely useful in detecting tumors or tumor progression or regression.

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So radionuclide Imaging studies, radionuclide bone scan or bone scan or bone scintigraphy, really increased uptake of tracers generally occur under abnormal conditions where there's high metabolic activity.

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And this is visualized as black areas or hot spots on an image.

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And so bone scans highlight areas of hyperfunction or increased mineral turnover.

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So if we look at image A here, bone scans of three different patients, each with three different diagnoses, degenerative arthritis and metastatic cancer and acute trauma.

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The point is that all the scans look alike because they only measure hypermetabolism.

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Thus, bone scans are not independent studies, but they have to be corelated with clinical data to be meaningful.

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And so image A, the patient has a degenerative joint disease in multiple sites.

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And so we can see, the arrows indicating increased uptake in the cervical spine.

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Here, see how it's black, and the wrist here, it's black, and in the ankles.

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You can also see in the knee here.

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And that actually is a prosthesis at the knee joint, so a total knee replacement.

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And then if we look at E right there, that patient suffered a bruise to their glute medius muscle during football game.

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And increase uptake was an early indication of myositis ossificans developing in the muscle, so these two things here.

00:12:32
So this person either landed on that side or someone hit them here, and now we have this development of bone that's turning over at a much increased rate versus everywhere else in the pelvis.

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Then if we look at C here, this patient has known lung cancer and the bone scan is done to identify the distribution of metastatic lesions in the skeleton.

00:13:00
And increased uptake at the right scapula and the right shoulder shows areas of metastatic bone cancer so that's here and so that's the scapula.

00:13:12
What?

00:13:13
Over the top of that thing.

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[BLANK_AUDIO]

00:13:19
So anyway, here and here.

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And so, we can see this is the right shoulder here's the humerus coming down here, and here's the torso there.

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00:13:36
So, the limitation here is just this lack of specificity, right?

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All we can see is that there's bone turnover.

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We're not able to distinguish what process is causing the increased uptake of bone or the increased bone turnover.

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So, you have to have other clinical evaluations.

00:13:51
Correlated with your bone scan in order to make a diagnosis for radionuclide bone scan or bone scintigraphy.

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00:14:06
So magnetic resonance imaging, MRI, no ionizing radiation is produced by the MRI, and the inflammation is instead produced by the interaction of the tissue with a magnetic field.

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MRI is primarily used in the evaluation of soft tissue trauma and joint derangement and tumors.

00:14:29
And so this image here is an MRI of the cervical spine.

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And in a here you can see the pons and B, you can see the spinal cord and C you can see the marrow of the C two vertebral body and D you can Visualize the, the intervertebral disc,C4, and five, right?

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So here's four, here's five, here's the disc.

00:15:00
Right?

00:15:01
Here's three.

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So ultrasonography or musculoskeletal ultrasound.

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These images are generated using reflected sound waves.

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Like an MRI, there's no exposure to ionizing radiation, and it's non-invasive imaging.

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Different tissues absorb and reflect the sound waves uniquely.

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Diagnostic ultrasound is useful for lesions to muscles and tendons, ligaments, detection of cysts and soft tissue tumors.

00:15:48
And for the measurement of blood flow.

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One meaningful advantage of ultrasound is that the images can be made during the physical examination of tissues, such as during muscle contractions or passive stretching, or even while performing special tests.

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So it's a very functional kind of imaging runs there the patient remaining static like they would be for an MRI or an X-ray.

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The patient can actually be moving and you can visualize the structures as they move through space.

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00:16:31
The functional view of imaging starts with the patient and the evaluation, including the history and the physical.

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As opposed, you decide that something doesn't seem quite right, so you refer the patient out for imaging, and the patient undergoes imaging, the report's generated, the radiologist makes the diagnosis.

00:16:51
And then proceed with treatment either a physical therapy or physical therapy is not appropriate with some other kinds of treatments.

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Essentially, diagnostic imaging is a link in a larger chain that starts and ends with the patient.

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So you have a picture or an image, but humans play a critical role in the imaging system.

00:17:12
Through their interpretation of the image and by their correlation of the clinical findings with the information from that imaging.

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So the clinicians responsibility really is to recognize that if the results of imaging that imaging study don't fit the physical findings, then further clinical evaluation and diagnostic investigation are warranted.

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4.1 Why View Diagnostic Images?

Effects
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Hi and welcome to week four, and so we are going to talk a little bit more about general principles and radiology.

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So this first section is really dedicated to describing why clinicians need to view diagnostic images.

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Unnecessary examinations and the overutilization of x-rays.

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And if we look at the quote for number 1, it is easier to order an x-ray than to think.

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And so we're dealing with an issue and we're trying to avoid overutilization.

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And overutilization means excessive radiation per unit of diagnostic information or therapeutic impact or health outcome.

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Essentially trying to limit the amount of radiation per useful bit of knowledge.

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That includes excessive radiation per image, or excessive images per exam, or excessive examinations per patient.

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We want that number to be as small as possible.

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Examples might be, how useful is imaging of the skull when you're evaluating a patient for headache, or neck pain, or vertigo, or seizures?

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A single lateral image would be adequate and would result in about a 75% to 80% reduction in radiation exposure versus other kinds of interventions.

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Lateral imaging, for example, of the chest and individuals under age 40 may add no new information and could safely be eliminated in the vast majority of cases.

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Oblique films of the lumbar spine in children are probably not useful, but they do result in high doses of radiation.

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So if we look at number 3, the lack of knowledge of the limitations of radiology, right, that can also cause overutilization.

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Essentially, it's the lack of knowledge regarding what radiology can and what radiology cannot do.

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And then what about number 4, the reliance on radiologic versus clinical findings?

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So there's the potential for an undue dependence on radiology.

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Are repeat examinations necessary?

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And if so, how frequently to follow up on a routine fracture healing, for example, especially if the patient's functional changes and symptoms depict their responses to treatment.

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00:02:51
Number 5 is the belief that every possible step is being taken to obtain a diagnosis, and so the clinician's need for action and certainty, right?

00:03:01
A PT may need to feel secure that they have taken every possible step to solve the puzzle of obtaining a diagnosis.

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So to resolve uncertainty, does bringing the radiologist into the decision making process really add value, does it cause harm?

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In other words, occasionally during this process, a clinician may feel that more is always considered better, but it may be useful to consider, for example, how much better and at what cost?

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So be careful of using radiologic examination as a form of psychotherapy that gives some kind of degree of assurance or reassurance that may or may not be justified.

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Taking an action, such as ordering imaging, whether or not it improves the ability to treat the underlying condition, really offers little benefit to the patient.

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00:04:01
So continuing with unnecessary examinations, why is there overutilization of x-rays?

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Well, part of it is patient demand.

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The patient may request an x-ray, whether or not it's relevant.

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For example, demanding an x-ray of an ankle, following a sprain, despite evidence from a set of rules indicating that imaging is probably not going to be incredibly useful.

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Reimbursement policies, when imaging is covered, you may be less concerned about the economic burden on patients.

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But as costs rise, or patients are required to fund, the likelihood of you ordering imaging may decline.

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Number 3, defensive medicine, so this really concerns the idea of malpractice.

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So back in the 1970s, research already suggested around 30% of x-rays were performed defensively by clinicians who may have been concerned about taking every possible step to guarantee that nothing has been missed.

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Regardless of the cost or the potential harm in terms of financial, or radiation, or the things that we've discussed previously.

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So there's a belief that if a finding is not documented, that the provider could be sued.

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And experts in the field suggest that these types of examinations are not valid, and that future litigation may instead result from unnecessary radiation exposure, because of needless examinations rather than from too few examinations.

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Finally, economic incentive, so physician-owned imaging units, staff in these offices ordering their own imaging, interpreting them, and rendering charges.

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There's an incentive to perform more rather than fewer imaging studies.

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Even 40 years ago, non-radiologist physicians who owned their own extra equipment used an average of twice as many x-ray examinations as their colleagues who referred out to radiologists.

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So in summary, unnecessary radiological examinations can result in excess costs, excess radiation, wasting a patient's time, wasting a clinician's time, false hope and expectations, increased worry over findings which are not clinically meaningful.

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And they indicate a breakdown in the logical thought pattern

concerning the patient's workup.

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So examples of unnecessary examinations then, and these are all taken from a radiology textbook for radiology residents.

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So taking imaging of a nasal bone to rule out a broken nose.

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And this is unnecessary because if there's a fracture of a nasal bone, it won't be casted and it will not be reduced, and no treatment will be given regardless of what the x-ray shows.

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Even if the nasal bone is displaced badly enough to warrant an intervention, a CT facial series to be useful only to search for additional fractures.

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How about rib imaging?

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Well, fractured ribs are not uncommon, however, finding a rib fracture after trauma has almost no clinical significance and really does not alter treatment.

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A pneumothorax or even a lung contusion may be ruled out by chest films, but a rib series isn't necessary.

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A rib x-ray on a patient with rib pain to find a fracture that really serves little purpose other than to find a cause for the pain, and eliminating this series of rib imaging really will not change the course of the patient's treatment.

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Coccyx imaging to rule out a fracture isn't necessary because a fracture of the coccyx will not be casted or reduced, just like the nasal bone.

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So in addition, a meaningfully higher dose of gonadal radiation results from a coccyx x-ray.

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So because no change in treatment will occur, regardless of imaging results, coccyx imaging is likely not necessary.

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Lumbar spine, so these x-rays, research suggests, are the most abused examinations of radiology.

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They result in the highest gonadal radiation dose of any x-ray examination, equivalent to a daily chest x-ray for six years.

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And in the vast majority of cases, they offer no useful diagnostic information.

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In patients under 40, there is almost no x-ray plain film finding that can be linked to the acute problem or that can be treated with an intervention linked to findings from imaging.

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Disc herniation cannot be identified.

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Tumors or infections are not usually considered unless there are specific criteria such as atypical pain, intravenous drug use for other potential causes of infection, history of cancer, etc.

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So instead, regardless of the findings on the x-ray image, modalities to reduce pain along with exercise or advice to stay active will invariably be the treatment of choice.

00:09:08
A lumbar spine x-ray series may be useful in cases of severe trauma, or possible metastatic tumor, or infection.

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Acute low back pain with, sorry, acute low back pain with radiculopathy is not an indication for x-rays.

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An MRI would be more useful for showing a disk herniation, but that should only be considered after conservative treatments such as physical therapy has failed.

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And ankle series, around 30,000 of these were reported every day in North America, and they're the most common cause for emergency department visits.

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An evidence-based history and physical examination using the American College of Radiology criteria and the Ottawa ankle rules can reduce ankle imaging by 50% without ever missing a fracture.

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So tiny bony avulsions in the foot and ankle will be treated the same as ligament tears.

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So because x-ray is not a factor in determining the patient's treatment, it can probably be avoided.

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The cervical spine and the cervical spine x-ray series, emergency departments routinely order C-pine films on all trauma patients because they're worried about not stabilizing a fractured back.

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Research has demonstrated consistently that patients who are alert and have no C-spine pain have almost no chance of having a fracture.

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If the patient doesn't lag and has no pain with cervical motion, no posterior midline tenderness, and no neurologic deficits, no C-spine x-rays should be performed.

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In the case of trauma, you can usually skip plain film and the patient is likely going to go straight to a CT scan to ensure that fractures are moved out.

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However, a CT may not show ligamentous disruption, but should be more easily seen on MRI.

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So in sum, there are a lot of things that typically will receive imaging, but from an evidence-based standpoint, probably the imaging isn't absolutely necessary.

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Interpreting images in radiology, develop a search pattern and

understand that the diagnosis is going to be complicated by normal anatomic variance, multiple diagnoses such as the second fracture.

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And the second fracture refers to when we become so fixated on diagnosing a particular fracture in a certain area that we end up missing a meaningful fracture in a separate area.

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Letter C, variations in how a disease may present, and D, insignificant findings, which become significant over time.

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So using a search pattern may seem to make diagnosing easy, but the interpretation can actually be very difficult.

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So interpreting images in radiology, the pitfalls.

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Number 1, we have errors of observation, 2, errors of interpretation.

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And 3, we can reduce errors by learning to appropriately communicate with the radiologist.

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So errors of observation have to do with a faulty search pattern usually.

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Errors of interpretation are the practitioner's failure to link abnormal radiologic signs to meaningful clinical data.

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And errors in reading images are inevitable.

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You just have to accept that they're going to occur, and occasionally things will be missed.

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4.2 Examinations and Interpreting Images

Effects
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So welcome to lecture 4.2, and we're going to continue with general principles in radiology.

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Our objectives for this portion are to describe bone remodeling and how it is related to function and then identify.

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Two kinds of errors when interpreting images and then define the ABCS or ABCs of how to begin radiographic analysis.

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So let's continue with radiologic evaluations, search patterns and diagnosis.

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So most of you have probably heard of Wolff's Law and well, this slide discusses the inner architecture of bones and its importance for bone growth.

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And this is the original article published by Julius Wolff in 1870.

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This is where Wolff's Law comes from.

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00:01:23
Bone remodels continuously throughout life and that remodeling is

directly related to the function.

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So, if we see here, Wolff's law use it, so you don't lose it.

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Julius Wolff's law was basically, as a consequence of the primary shape variations in the continuous loading or even due to loading a long bone changes its architecture according to some mathematical rules.

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And as a secondary effect and governed by those same rules, the bone shape also changes.

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And so we see here on this side, what this is illustrating is really the inner architecture of the bone here.

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And we can see these very dense areas here and less dense areas here.

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And the theory here, according to Julius Wolff, is that that architecture or that density shape change based on the kinds of loading that the bone is exposed to over time.

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So the direction and pattern of loading influences the pattern of the trabecular framework.

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And this is a drawing of forces and trajectories of forces affecting bone and the force distribution.

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And so on the left here this is supposed to be a curved beam and on the right here is a femur.

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And the drawings represent the forces that the beam is exposed to and the forces that the femur is exposed to.

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And we can see the trabecular patterns and the stress trajectories of this this beam and how they're kind of similar, right?

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And so that's sort of the inside.

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So the architecture of the human femur and it was compared with these sort of mathematically constructed stress trajectories on this beam.

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And that was to show how a human femur can be loaded in a single leg stance was sort of idealized.

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But the structure was called Coleman's Crane.

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And the takeaway here was really that besides the basic static relationships, the arrangement of the cross section, the inside of the bone and this beam.

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And the mechanical influences of the muscle tension, and the ligament tension, and the loading, those all influence the shape and the inner structure.

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And this was important because Wolf was basically convinced that the similarities between those stress trajectories in the brain on the left and the trabecular patterns and human femur were coincidental.

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And so he hypothesized that the direction and the pattern of loading influences or controls the pattern of the trabecular framework in the bone, so that's sort of the origin of Wolf's emphasis on mathematical laws.

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In other words, that there's a direct mathematical relationship between the form or the shape of bone and the load that's imparted on that bone over time.

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So, remember that bone remodels continuously throughout life, and that the remodeling of bone is directly related to the function of the bone.

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And when we look at this slide up at the top, the first thing you'll see here is this ACL tear.

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And this is illustrating, for example, an A on the left, this is a bone that's been exposed to an ACL tear right here.

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And on the right, this is a bone that has not been exposed to an ACL tear.

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And so we see variations in bone shape that are associated with the abnormal kinematics, right, so the joints move differently after an ACL reconstruction.

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So we can look at the shape here, right here, of the medial femoral condyle, how it's sort of an oval.

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And then on the non-ACL tear we can see the medial femoral condyle is more of a circular shape.

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On the left over here we can see the medial tibial slope here is pretty straight across and on the right and the normal you can see that there's actually sort of a slope on the medial tibia.

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And in B, what we're looking at here is coxa valga, so an increased angle between the head and neck of the femur.

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And the point of showing you this was to illustrate how the stress changes based on the angle of the neck of the femur.

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And so the darker are higher values of stress.

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And then finally you can see over here we're looking at bone

remodeling in a person with osteoarthritis with some bone marrow edema and knee pain.

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So, when viewing images, there are two kinds of errors when interpreting an image.

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One is an error of observation due to an incomplete or a faulty search pattern.

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Two are errors of interpretation, and that's the health care provider's failure to link the findings from the imaging to meaningful clinical data.

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Both of these can be reduced when the referring provider, for example a physical therapist offers their expertise from their specialty.

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To collaborate with the radiologists to improve the quantity and the quality of information that in turn increases the likelihood of a positive patient outcome.

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So in a nutshell, what I'd like to sort of convey with this slide is the more and the higher the quality of the information you can provide to the individual who is going to be taking the images and interpreting the images, the more likely you are to get some useful information from that imaging, and the more likely you are to help the patient.

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00:08:09
So ABCS, the ABCs, how to search through radiologic imaging.

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And we have alignment, bone density, cartilage spaces, and soft tissues, these are the four things that we look at.

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And ABCS is the search pattern for radiologic image interpretation.

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And note that there are three components for each A, B and C, and there are five components for the S, the soft tissues.

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You can also see table 2-1 in your McKinnis text for more information

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So we'll begin with alignment and alignment we're looking at skeletal architecture first.

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So skeletal architecture we're looking at changes in the size of bones or extra bones, congenital anomalies, the absence of bones or developmental deformities.

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And some examples for altered size of bones include gigantism, or has used disease or acromegaly.

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For extra bone you might see polydactyly, congenital anomalies might include a cervical rib or transitional vertebra at lumbosacral junction.

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And for the absence of bones, we could think of things like possibly an amputation or congenital abnormality.

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And then finally for developmental deformities scoliosis or genu valgum are pretty decent examples of that.

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So starting on the left, we have Paget's disease here, and that's the random proliferation of osteoblastic and osteoplastic activity.

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So bone formation and bone resorption that's just random.

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And it produces these curious fluffy areas as fluffy sclerosis of the enlarged skull.

00:10:04

And this elderly man here with acid.

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So these are the clip areas here.

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And so the lateral view of the skull gets an appearance of spots of, quote, cotton wool, unquote, that's what it's referred to.

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And this is a classic radiographic finding during later stages of Paget's disease.

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In the middle, we have polydactyly in a ten month old child.

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And what you should note here is the six digit, right?

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So we have one, two, three, four, five, six.

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And finally, on the far right over here, we have congenital deformities in an eight-month-old girl, which include bowing of the femurs and bowing of the tibias with an absence of fibulas.

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There aren't any femurs aren't any fibula is present there are fevers present.

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So continuing with alignment, remember to contour bone, so we're looking at the general contour bone.

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This includes internal and external irregularities.

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The cortical outline of each bone osteophytes breaks or gaps in the continuity of the cortex, or markings related to past surgeries.

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So some examples of internal and external irregularities could be

related to disease or trauma or developmental or congenital factors.

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The cortical outline following should be smooth and continuous that we should imagine for example in the long run we should see this.

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Osteophytes or bony upwards that occur at joint margins that are usually associated with degenerative changes of cartilage.

00:11:58
Along with those, a spur is an osteophyte that looks pointy and isolated, and can also form tension at tissue attachment sites.

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So breaks are gaps and the continuity of the cortex of the bone signify a fracture usually markings related to surgical history can include bone graft donation sites or drill holes for surgical implants such as plates or other fixation devices.

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Note that alignment architecture and alignment contour aren't mutually exclusive.

00:12:32
So for example, the dementia in general deformation in architecture also falls under bony contour.

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So continuing with some imaging examples here, we'll start on the left with this osteophyte or heel spur and this is seen as a radio-dense projection at the margin of the anterior inferior surface of the calcaneus.

00:13:02
We can see that in the little black circle there.

00:13:06
Next in the middle here we have an example of a cortical fracture, seen in a complete fracture of the fifth metacarpal neck at the arrowhead here.

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This is referred to as a boxer's fracture.

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Finally, note the odd appearance of old surgical sites corresponding

with the arrowheads.

00:13:29
And this patient had a fibular fracture and a dislocation which was repaired with a plate running along the shaft of the fibula and compression screws across the tibia to reestablish the stability of the ankle bones.

00:13:42
And you can see faint remnants of the drill holes.

00:13:45
And there's these radiolucent lines, and you can also see faint lines across the tibia that are radio-dense.

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So hardware like this is usually not removed until it becomes problematic as a result of infection or loosening.

00:13:57
So we can see these white arrows here, and corresponding with those, you can see faint lines right here.

00:14:05
We have hardware and also right here we look at this arrow and see this pink line.

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Finally, under alignment number three, position of bones relative to other bones.

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So the alignment of bones relative to other bones, we want to assess for normal positional relationships, looking for fracture or dislocation or subluxation.

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And a fracture can disrupt a joint articulation, usually it's due to trauma.

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A dislocation will also disrupt normal articulation, also due to trauma.

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A subluxation, on the other hand, is a partial dislocation, and that can be related to trauma, but can also be related to degenerative

changes that result in changes of the congruence between joint and joint laxity.

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So on the far left is a normal shoulder, followed by an image of the humerus posteriorly dislocated from the glenoid.

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And so the glenoid is this area right here, you can see.

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The humerus sort of obscures the posterior aspect of the glenoid in this picture on the left.

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However, on the right or in the middle here, you can see the full glenoid because that humerus is dislocated posteriorly.

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Now on the far right we see an image of a dislocated hip.

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And it's rare, and in this case it was the result of a road traffic accident and the patient underwent a closed reduction in recovery.

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And so what we can see here is this is where the femur should be, and this is where the femur hits

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4.3 Bone Remodeling and ABCS—A

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So we'll continue with part three, general principles and radiology.

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And our objective in this lecture is to continue with the ABCs of how to begin a radiographic analysis.

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And in this lecture, we're going to explore bone density and cartilage space.

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So in the ABCDs for B, which stands for bone density, we're looking at number 1 of 3.

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And number 1 is skeletal architecture.

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So the general bone density is what we're looking at here, and we're going to assess the shade of gray, looking for shades of gray and then apply sufficient radiographic contrast between the bone and the soft tissue, and sufficient contrast within the bone itself.

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So sufficient contrast between the bone and soft tissue, what this means is that healthy bone and soft tissue appear with clearly different or distinct shades of gray.

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And sufficient contrast within the bone itself means between the denser cortical shell of each bone and the less dense cancerous bone center.

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And the healthy cortex shows up with greater density than the cancerous bone, and it appears as a white margin along the bone shafts.

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And so what this means is that if we're looking at a long bone, the outside of the bone here, the edges will appear bright and the insides

here will appear less bright.

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And on the left, we're looking at the normal density of a proximal femur.

00:01:51
And on the right, we're looking at a femur with osteomalacia, so a femur with less density.

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So note that normal bone density is evident in the increased radiodensity and thickness of the margins of the femoral shaft, and that's where the outlines are here, right?

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So again, on the outside, we can see that it's more radio dense or brighter, and that's in contrast with the normally lesser radiodensity of the medullary cavity in the center of the bone here.

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So just like in the last slide, you can see that the center here is less dense than the outsides.

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So osteomalacia on the slide on the right, that's also known as adult rickets, and this is a hypocalcification disorder, so less bone.

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As seen in this proximal femur, the body is able to produce bone, but it's not able to calcify it.

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So the result is a very wide but a porous femur, and the classic radiologic finding is a looser zone.

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A radiolucent band, which is transverse to the cortex, and it's an insufficiency stress fracture related to the demineralized cortex.

00:03:08
And the slight increased radiodensity on either side of the fracture line is the bone's attempt to repair that area of stress.

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And so one of the things you'll notice with imaging is that often, the things that you're looking for are really subtle, and so it's right in between those red lines, we can see that.

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I think the most important thing I'll have you take away from this slide was really the brightness of the outer edges of the bone on the left image, that healthy femur, and the less dense center of the femur.

00:03:44
And then on the right image, noticing how transparent or darker that femur is versus the healthy femur on the left.

00:03:53
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So number 2 under bone density is textural abnormalities.

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And we're going to look for changes in appearance of the trabeculae, and changes in mineralization, which result in changes in the appearance of the trabeculae.

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And so when the mineralization of the bone is altered, the appearance of the trabeculae is also altered.

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So the altered trabeculae appearance is often a radiologic hallmark in the diagnosis of disease processes.

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The image of the trabeculae is often described in terms like textures such as thin or delicate, or [UNKNOWN], smudge, or fluffy.

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And on the right, we have cortical thinning as a result of Cooley's

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So on the left, this is a previously healthy 21-year-old man who'd been troubled for the last 18 months by progressive loss of strength in his legs.

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And he was found to have primary hyperparathyroidism due to a tumor of the parathyroid.

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And the radiograph of his leg shows these generalized skeletal changes with considerable decalcification of the bones and erosions of the cortex.

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And so we can see here, if we look at the tibia, even the cortex, and we can see what we're looking for is this sort of straight line, and we're not seeing that, right, we're sort of seeing these edges that are kind of rough.

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And then even within the texture of the inside of the bone here is just normal translucent.

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And on the right, what we're looking at is this lacy appearance of the trabeculae of the upper extremity of this child due to Cooley's anemia, and that's an inherited blood disorder that results in destruction of red blood cells.

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The metacarpals and the phalanges show cortical thickening and osteopenia.

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And marrow proliferation results in a loss of normal tubulation, which results in a squared or sausage shape of the bones in the hand.

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And so if you look at the metacarpals here on this hand, you can see then as opposed to the normal shape, right, they're sort of off.

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So we're looking for increases in bone density in weight-bearing areas, like sclerosis, as well as excessive increases in osteoarthritic conditions and reactive changes, which occur when the body acts to contain a diseased area.

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So sclerosis or normal increases in bone density are seen in areas that are subjected to increased physical stress, such as the weight-bearing areas of joints.

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These areas of localized sclerosis are actually signs of repair, where extra bone is deposited to fortify the bony architecture to withstand the forces of weight-bearing.

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Excessive sclerosis, that can be normal, so when bone is healing, it forms a callus as if remodeled, but it can also occur during degenerative changes such as arthritis.

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And reactive sclerosis, that occurs during conditions such as reaction to a tumor or cancer, and the body may lay down bone as it attempts to surround and contain the diseased area.

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And so in this AP view of the knee, what you should see is this classic radiographic hallmark of arthritis, which is demonstrated by decreased medial joint space combined with sclerotic subchondral bone

of the medial tibial plateau, and that's what's in this oval.

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So we can see that the space here is narrowed.

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And then we can also see,

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And this nine-year-old girl had a six-month history of progressive, enlarging soft tissue swelling at the right proximal tibia, and she was diagnosed with osteomyelitis at the proximal tibia.

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And what you should note here is how the region is well circumscribed by the reactive sclerosis of bone as it attempts to surround and wall off the infected area, and that's what the arrows are.

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So that really great, great, shiny part there, that's bone reacting and trying to wall off.

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And in B, the CT axial image further demonstrates that sort of reactive sclerosis of the left tibia, and also reveals the draining effect, and that's the white arrow, which was formed to relieve the pressure of the pus on the bone.

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And so right here, again, it's very subtle, but you can see that sort of dent right there.

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So the pus drained out into the soft tissue, which enlarged the circumference of the leg, and that's what we see in this axial view.

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So again, I think the takeaway on the image on the right is just noting how this bone is reactive here, a little brighter as it tries to wall off that area, and especially in the CT down below here.

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You can really see that brightness.

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And then for number 2, if the space is decreased, that's likely the result of degenerative changes.

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So a well-preserved joint space implies that the cartilage or the disk is of normal thickness.

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An MRI image of a patient with degenerative disk disease, it shows bands of fatty bone marrow parallel to the L5 disk right here.

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And so we can see this sort of fattiness, and we can see this degenerated disk here.

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And on the right side, we see degenerative disk disease at the cervical spine.

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And this lateral view of the cervical spine shows the classic hallmarks of degenerative disk disease at C56, including a narrow joint space, an osteophyte formation at the vertebral end plates.

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And so you can see these little spurs popping up there, these osteophytes.

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I think the important thing I would take away from these two images are looking at the difference here in the joint spaces here,

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And compare that with this joint space, and it's the same on the other image, right?

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And look here at the joint space, and then we'll compare that with this one.

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Continuing with cartilage spaces, number 2, the subchondral bone.

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You want to assess the subchondral bone, looking for changes in density or irregularities.

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And increased sclerosis could be one finding.

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For example, in osteoarthritis, the subchondral bone becomes increasingly sclerotic as new bone is formed to help withstand the increased stresses directed at it because of the loss of the articular cartilage.

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So if you recall from a few slides ago, you could see how those brighter areas of bone were created along that medial femur and tibia, as that joint space became more narrow.

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Then the other thing to be aware of are erosions.

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So in rheumatoid arthritis or gout, you see very little reparative sclerosis in the subchondral bone.

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And instead, you see erosions of the subchondral bone in the form of radiolucencies of the joint margin.

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And so what that means is that it's very transparent and it's not the right response that we saw with that sclerotic change.

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So in this image, the left hip joint space narrowing reflects the loss of cartilage and changes in bone density and bony irregularities.

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So osteoarthritis is a destructive joint disease that can result in pain, it can result in stiffness, as well as a loss of range of motion or a loss of activity tolerance.

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And X-rays can confirm the diagnosis of osteoarthritis.

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So X-rays demonstrate a number of findings in osteoarthritis, although they're not always seen, and they can occur in different variations from individual to individual.

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So the first thing that we see here is joint space narrowing, and that reflects the loss of cartilage.

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So we can see the joint space narrowing here, and all through the side when you look at that compared with this joint space.

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The second thing that we can see is sclerosis, which is present in almost all cases of osteoarthritis.

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And again, sclerosis is that brightness that begins to appear here in reaction to that loss of space and cartilage, right?

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And look at the amount of brightness there compared to the right big joint.

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And finally, there's osteophytes present, so a new bone formation around the joint in reaction to that stress.

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And then subchondral lucency, which is a focal loss of bone density.

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Continuing with cartilage spaces, number 3 are the epiphyseal plates.

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We want to assess the epiphysis, look for changes in the position of the growth plate or the size of the epiphysis, whether the borders are smooth and whether there's presence of disruption or gaps in the plates.

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So the position of the growth plate as designated by the relationship of the ossified portion of the secondary epiphysis to the metaphysis.

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We can see that in figure 221 in your radiology text.

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And the size of the epiphysis in relation to both the skeletal maturity and the chronological age of the patient has been imaged.

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Is there's a smooth margin at the borders of the epiphysis, like a band of sclerosis, indicating increased bone activity associated with linear growth?

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Disruptions in the growth plates from trauma or metabolic disease can be visualized, and those can be difficult to diagnose and they may require contralateral films for comparison.

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So often, one of the keys in imaging is symmetry, comparing one side to the other side.

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4.3 Bone Remodeling and ABCS—A

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So we'll continue with part three, general principles and radiology.

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And our objective in this lecture is to continue with the ABCs of how to begin a radiographic analysis.

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And in this lecture, we're going to explore bone density and cartilage space.

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So in the ABCDs for B, which stands for bone density, we're looking at number 1 of 3.

00:00:36
And number 1 is skeletal architecture.

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So the general bone density is what we're looking at here, and we're going to assess the shade of gray, looking for shades of gray and then apply sufficient radiographic contrast between the bone and the soft tissue, and sufficient contrast within the bone itself.

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So sufficient contrast between the bone and soft tissue, what this means is that healthy bone and soft tissue appear with clearly different or distinct shades of gray.

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And sufficient contrast within the bone itself means between the denser cortical shell of each bone and the less dense cancerous bone center.

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And the healthy cortex shows up with greater density than the cancerous bone, and it appears as a white margin along the bone shafts.

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And so what this means is that if we're looking at a long bone, the outside of the bone here, the edges will appear bright and the insides

here will appear less bright.

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And on the left, we're looking at the normal density of a proximal femur.

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And on the right, we're looking at a femur with osteomalacia, so a femur with less density.

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So note that normal bone density is evident in the increased radiodensity and thickness of the margins of the femoral shaft, and that's where the outlines are here, right?

00:02:08
So again, on the outside, we can see that it's more radio dense or brighter, and that's in contrast with the normally lesser radiodensity of the medullary cavity in the center of the bone here.

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So just like in the last slide, you can see that the center here is less dense than the outsides.

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So osteomalacia on the slide on the right, that's also known as adult rickets, and this is a hypocalcification disorder, so less bone.

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As seen in this proximal femur, the body is able to produce bone, but it's not able to calcify it.

00:02:51
So the result is a very wide but a porous femur, and the classic radiologic finding is a looser zone.

00:02:59
A radiolucent band, which is transverse to the cortex, and it's an insufficiency stress fracture related to the demineralized cortex.

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And the slight increased radiodensity on either side of the fracture line is the bone's attempt to repair that area of stress.

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And so one of the things you'll notice with imaging is that often, the things that you're looking for are really subtle, and so it's right in between those red lines, we can see that.

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And then on the right image, noticing how transparent or darker that femur is versus the healthy femur on the left.

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And again, sclerosis is that brightness that begins to appear here in reaction to that loss of space and cartilage, right?

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And look at the amount of brightness there compared to the right big joint.

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And finally, there's osteophytes present, so a new bone formation around the joint in reaction to that stress.

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We want to assess the epiphysis, look for changes in the position of the growth plate or the size of the epiphysis, whether the borders are smooth and whether there's presence of disruption or gaps in the plates.

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So the position of the growth plate as designated by the relationship of the ossified portion of the secondary epiphysis to the metaphysis.

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We can see that in figure 221 in your radiology text.

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So often, one of the keys in imaging is symmetry, comparing one side to the other side.

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4.4 ABCs—Soft Tissue

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So lecture 4.4.

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We're going to continue along with our general principles and radiology.

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And our objective here is to continue with our ABCS radiographic analysis.

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And we've gotten through A and B and C alignment, bone and cartilage.

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Now we're on soft tissues, S.

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But before we get to our soft tissues, I want to backtrack a little bit to our last lecture, where we were talking about the epiphysis.

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And the Salter-Harris classification system addresses physeal fractures.

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On the left we have a type IV fracture of the distal tibia, and on the right we have normal epiphyseal plates.

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So here's an image of a patient who presented with ankle pain after being tackled while playing rugby.

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And this is a Salter-Harris type IV, where the fracture passes through the metaphysis, the growth plate and the epiphysis.

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And so, it's really faint again, you can see it's recording right here

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00:01:18
And so, this is referred to as a triplane fracture, and they tend to occur at the distal tibia.

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So, on the right is a normal radiographic appearance of a hand of an 8-year old child, and the borders of the epiphyses are normally bounded by a smooth margin with a band of sclerosis indicating increased bone activity.

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And so, that's fine, that is a really nice one, because you can see how great that is right there.

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00:01:48
And this is how they're distinguished from fracture fragments, with that really, really bright band of sclerosis from the increased bone activity, all right?

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So now, we'll get back to soft tissues from our ABCS.

00:02:03
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00:02:06
So, under soft tissues, number one is muscles, and we can assess the soft tissue of the muscles, looking for changes in muscle girth that might represent muscle wasting or gross swelling of muscle and soft tissues.

00:02:18
And so, although tissue densities appear similar on radiographs, because tissue has limited density compared with bone.

00:02:26
In extreme circumstances, some properties of the soft tissue can actually be visualized, and gross muscle wasting could suggest a primary muscle disease paralysis, or some sort of severe illness or disuse attribute is secondary to trauma

00:02:46
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00:02:48
Gross swelling for example of muscles and soft tissues could also be

indicative of inflammation or edema, hemorrhage, or tumor.

00:02:58
So essentially, looking at the size or the girth of the muscle can be indicative of different pathologies.

00:03:03
[BLANK_AUDIO]

00:03:09
So, in this image, we're looking at disuse atrophy of the quadriceps, and this is disuse atrophy of the quadriceps secondary to a traumatic patellar dislocation.

00:03:20
And you can see the shrunken and concave appearance of the soft tissue outlining the thigh.

00:03:26
Look at the inferior position of the patella related to the quadriceps insufficiency, right?

00:03:32
And so, here on the other leg, this is the normal patella position.

00:03:38
And on the right side, you can see it's really free.

00:03:41
You can see how the patella was dropped down there.

00:03:44
And also, even more there, and you can see the bulk of the quads here on this one.

00:03:52
You can see it's all these.

00:03:55
[BLANK_AUDIO]

00:03:57
Okay.

00:03:57
[BLANK_AUDIO]

00:04:00
This is a really excellent drawing.

00:04:01
Bob Ross-like drawing, I suppose.

00:04:04
[BLANK_AUDIO]

00:04:11
So, continuing with our soft tissues.

00:04:12
Number 2 is fat pads, and we want to assess the fat pads looking for changes in the position of the fat pads.

00:04:20
And this is usually a result of swelling and possibly an injury to an adjacent structure.

00:04:25
So, although soft tissue densities may appear similar, again, we're looking more at girth or maybe location of soft tissue on one extremity compared to another extremity.

00:04:40
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00:04:44
So, in this image, on the left, we're looking at a normal pronator quadratus fat pad.

00:04:51
And on the right, we're looking at anterior bowing of the pronator quadratus fat pad.

00:04:58
So, on lateral wrist radiographs, the pronator fat pad usually appears as a thin, radiolucent triangle with its base attached to the palmar surface of the distal radius.

00:05:10
And the bowing on the right could be the result of a fall, a muscle strain, an inflammatory condition or infection, or septic arthritis at the wrist, but that bowing is a result of fluid.

00:05:25
So, you can see how it kind of bulges out there, as opposed to this side, and it's pretty straight

00:05:38
[BLANK_AUDIO]

00:05:44
So, continuing with soft tissues, number 3 is joint capsule, we want to assess the joint capsule.

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Usually you can't see these well, but they become visible when swelling is present.

00:05:53
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00:05:55
And so that swelling is seen and exacerbations of arthritic conditions, like infection or hemophilia, and acute joint trauma.

00:06:05
Effusion from the trauma and intra articular fracture may produce a lipohemarthrosis in the joint capsule, and a lipohemarthrosis is the mixture of fat and blood from the marrow, which enters the joint space through an osteochondral defect.

00:06:22
And so because fat is less dense than blood, the fat floats on the surface of the blood.

00:06:27
On a radiograph, this is referred to as a fat fluid level or a fat-blood interface, FBI sign fat-blood interface.

00:06:39
And somewhat seen on a radiograph it's a sign or a strong indicator for potentially overlooked intra articular fracture.

00:06:46
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00:06:51
So, this is the fat-blood interface sign, the FBI sign, and this is a non-weight-bearing lateral view of the knee, and marrow and blood that seep through the intra-articular tibial patella fracture, which we can't see here.

00:07:08
It has accumulated in the suprapatellar area of the joint capsule, and divided into layers because of differences in fluid density.

00:07:17
And a fracture has to occur for this sign to be present.

00:07:21

[BLANK_AUDIO]

00:07:25
So, I think a couple of important things we need to recognize.

00:07:28
Number one, we have the joint space here between the tibia and the femur, and the we have the patella here.

00:07:34
And then note the difference in the densities here, you can see the fat and the blood interface.

00:07:41
But the other thing I think that's important to recognize is that, if we look at the contour of the skin here.

00:07:49
You can see how it's kind of pushed out, and that's a result of the fluid accumulation here, between the blood and the femur.

00:07:58
[BLANK_AUDIO]

00:08:01
And the soft tissue.

00:08:02
[BLANK_AUDIO]

00:08:11
So, continuing with soft tissues, number 4 is periosteum.

00:08:14
And the periosteum is assessed for any kind of reactive process, so a solid reaction for fracture healing or osteomyelitis.

00:08:23
A laminated process due to repetitive injury, a sunburst as a result of malignancy, or a Codman's triangle due to a tumor, hemorrhage or other trauma.

00:08:34
So, normally, rather than distinct, the periosteum can become evident in its response to abnormal conditions.

00:08:41
And you can actually see this in your McKenna's textbook, figure 2 dash 26.

00:08:47
And a periosteal reaction is generally described as being one of four types, and by the characteristic radiographic images.

00:08:56
So, look for these types of periosteal reaction.

00:08:58
A solid Is a reaction that indicates an indolent or slow rolling process which is seen in fracture healing, in chronic osteomyelitis, laminated or onionskin kind of shape or outline, and this reaction indicates repetitive injury.

00:09:18
As in battered child syndrome, it's also associated with sarcomas, a sunburst or speculated pattern.

00:09:26
So, this reaction is almost always associated with malignant bone lesions such as sarcomas, and is frequently seen in metastatic squamous cell tumors.

00:09:36
The distinct appearance of the periosteum is due to the repeated breakthrough of the tumor, the neoplastic process, followed by a new periosteal response.

00:09:48
And finally, Codman's triangle, where a piece of the periosteum is elevated by abnormal conditions and it ossifies in a triangular shape.

00:09:56
And this can be present in a variety of conditions, including a tumor, a subperiosteal hemorrhage in battered child syndrome.

00:10:03
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00:10:11
And periosteal reactions to abnormal conditions appear on radiograph in four characteristic images, all right?

00:10:18
The solid and the sunburst here, and then the onionskin, we have these layers, right?

00:10:28
And finally Codman's triangle.

00:10:29

So, the Codman's triangle, it might be helpful to imagine you have your bone here and something kind of pushes that bone out, and continues to push it out like this.

00:10:41
[BLANK_AUDIO]

00:10:43
And it develops into a triangle shape.

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[BLANK_AUDIO]

00:10:52
So, soft tissue is number 5, miscellaneous soft tissue findings.

00:10:57
We assess for out-of-the-ordinary soft tissue findings.

00:11:00
So, gas as a result of gangrene or trauma, calcification, or foreign bodies.

00:11:07
So, gas in soft tissue is an indication of gas forming organisms such as gangrene or trauma, and calcifications in soft tissues can be the result of cold trauma where a hemorrhage is coagulated and calcified.

00:11:21
Calcifications also occur in vessels and organs, for example, renal calculi or gallstones, or calcifications in the abdominal or the organs, those can be seen on radiographs.

00:11:33
And finally, things like foreign bodies, such as metal shards, you can also see those on soft tissues on radiographs.

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00:11:44
So in this image, we're looking at myositis, ossificans of the elbow and forearm.

00:11:49
This is an AP view of the elbow, and heterotopic bone is developed in the soft tissues of a forearm of this 53-year old man after a biceps tendon tear, and a repair with a Mitek suture anchor.

00:12:04

So, the boundaries of that abnormal tissue are here.

00:12:09
[BLANK_AUDIO]

00:12:13
Okay, this is the heterotopic bone, and then here, you can see some hardware, right in there.

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4.5 Skeletal Pathology—Categories, Distribution, Predictors

00:00:01
So, we're going to continue with 4.5, Moral and General Principles in Radiology,

00:00:07
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00:00:11
And the objectives of this lecture are to identify categories of skeletal pathology.

00:00:17
And provide examples of each, and identify the different distributions of skeletal pathology and provide examples of each.

00:00:24
And finally, identify predictor variables of different skeletal pathology, and provide examples of each.

00:00:35
So radiologic diagnosis of skeletal pathology.

00:00:39
So skeletal pathology can be organized for diagnosis by identifying the category of pathology, distribution of the lesion, and the predictive variables that characterize the disease features.

00:00:52
So in the picture on the right is a 54 year old with benign osteochondromas and the proximal humerus be you can see that.

00:01:01
[BLANK_AUDIO]

00:01:09
See that right here?

00:01:12
And this is sort of orient yourself, right?

00:01:15
[INAUDIBLE] Okay.

00:01:21
So in the proximal humerus and then in the proximal and distal femur C.

00:01:28

And so here's our femur,

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[BLANK_AUDIO]

00:01:37
So we can see that it's sort of a funny shape there.

00:01:40
[BLANK_AUDIO]

00:01:43
All right, and then also in the proximal tibia, D.

00:01:47
And so, down here is our tibia, again, in a really funny shape.

00:01:52
[BLANK_AUDIO]

00:02:02
And so, if we identify the category of the pathology, the category here is neoplastic, or identifying the distribution of the lesion.

00:02:11
The distribution is diffuse, all right, so we can see that it's throughout the body.

00:02:18
And then the predictor variables are osteoblastic.

00:02:22
You can see that it creates me a bone if you look up in B, right and see this new bone here.

00:02:28
If we look at the femur here, you can see that femurs made a new bone if we look at the tibia here, you can see that the tibia has created a new bone here.

00:02:37
And in terms of location, it's usually located around the knee of the distal femur and the proximal humerus, and that's what we see in the images in this patient.

00:02:49
It's usually in the metaphysis or the diaphysis.

00:02:53
It occurs in men more than women.

00:02:55
And then it's sharply defined, it's a slow growing lesion.

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[BLANK_AUDIO]

00:03:04
And then the shape is usually longer than it is wide.

00:03:08
And that's sort of what we see here too again, if you look at B, right, this is sort of a long [INAUDIBLE] But it can also be broad based triggers for like growth.

00:03:25
A really important one here though is that the joint space is usually preserved, right?

00:03:30
And so we look here at this femural joint.

00:03:33
We still have space in there if we look between the tibia and the femur, we still have space in there, you can see that space here too.

00:03:45
And the bony reaction, it's, it's usually encompassed by a cartilage cap.

00:03:51
And finally, the matrix production is mixed and there's no soft tissue changes and no history of trauma or surgery.

00:03:58
[BLANK_AUDIO]

00:04:05
So when we think about, again, the radiologic diagnosis of skeletal pathology, we're looking at number one, identifying the category of the methodology.

00:04:15
The different categories include, for example, congenital, right from birth, so the presence of a cervical rib, inflammatory having to do with vascular structure, osteomyelitis, rheumatoid arthritis, gout, metabolic, such as Paget's disease or fibrous dryplasia.

00:04:37
Aa neoplastic category like a bone tumor, a traumatic category like a

broken bone fractured, a vascular category such as avascular necrosis or fever, and then finally a miscellaneous or other, which can include things like an infection or osteoarthritis.

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00:05:00
So as we look at the categories, we'll start here with the inflammatory category.

00:05:05
And what we're looking at in this slide is ankylosing spondylitis.

00:05:10
And both of these images are from a 66 year old man on the left, the ossification of the outer fibers of the disc.

00:05:19
The amylose fibrosis and the alpophaseal joints have fused, so we can see the ossification of the outer fibers of the disc here, and the other thing that's.

00:05:38
Here's a look at this bonding activity here.

00:05:42
[BLANK_AUDIO]

00:05:44
On the right, ligamentous ossifications and you can also see fusion of the apophyseal and sacroiliac joints.

00:05:52
Usually, there's more dark appearing cartilage, but that's been replaced by bone matrix.

00:05:58
You can see that in the red arrow here.

00:06:01
And then like your takeaway from the right which is really just the amount of bone that's present, the amount of bright image that's present in this picture.

00:06:11
And we can just see

00:06:12
[BLANK_AUDIO]

00:06:16
That much of a gap in here or here too, and we don't see a lot of smoothness when you see a lot of [UNKNOWN] Going matrix,

00:06:26
[BLANK_AUDIO]

00:06:32
So the next category we're going to look at is the metabolic category, sample here is nutritional rickets.

00:06:42
And so what we're looking at in these images is nutritional rickets and a femoral fracture in a three year old female.

00:06:50
So on the left we have AP radiograph of both knees, and we can see a fracture of the distal right femur with a black arrow right here, and if you remember our ABCs.

00:07:02
The alignment here is off, so this is not very well aligned.

00:07:11
We can also see fractures of the right tibia and both fibula, and that's at the dashed white pearls right down here.

00:07:20
And you can see this one down here [INAUDIBLE] We can also see this sort of fragmented or frayed and fractured metaphyses, and that's at the solid white arrows here.

00:07:35
So we can see this just doesn't look very distinct and solid, it's kind of hanging off to the side here.

00:07:42
Same with this one over here.

00:07:45
So the image on the right is the same individual two years later.

00:07:50
And you can see this sort of diffuse osteopenia, as you can see following the tibia, right here, and you can see following the fibula here.

00:08:03
We can also see widened growth plates here,

00:08:05
[BLANK_AUDIO]

00:08:09
And we can see the sclerosis and irregularity on metapasis.

00:08:13
The arrows point to the sclerotic metaphysial bands due to alternating periods of adequate and inadequate mineralization.

00:08:23
That may be due to or related to the adequacy of nutrition during certain periods of time versus inadequate nutrition during other periods of time.

00:08:35
Again, that sort of white space here, I guess that's for those [INAUDIBLE].

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[BLANK_AUDIO]

00:08:47
So once we've identified the category, now we want to identify the distribution of the lesion and whether it's a monoarticular such as a fracture affecting only one bone or joint.

00:08:59
Polyarticular, such as rheumatoid arthritis, which can affect multiple bones or joints, or diffuse, such as osteoporosis or bony metastases, which can affect all or nearly all the bones or joints, like neoplastic and metabolic disease.

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00:09:20
So here's a diffuse distribution and this is metastases and we can see why spread sclerosis.

00:09:27
So again, sclerosis is this increased bone density that increase brightness of the pelvis and the sacroiliac region.

00:09:34
And the vertebral bodies of the thoracic and lumbar spine appear of sclerotic with a loss of the pedicles bilaterally.

00:09:50

And so you can sort of see, really distinct, whichever bodies looks like there's just nothing attached to them.

00:10:04
[BLANK_AUDIO]

00:10:05
So now we're going to identify some predictor variables that suggest seeing table to dashboard in your McInnes text for some additional information.

00:10:17
So the behavior of the lesion, is it osteolytic or osteoblastic or next?

00:10:24
And so we may see geographic destruction of areas of bone that become destroyed or moth eaten appearance where there are small holes and ragged borders.

00:10:35
Or we might see permeative destruction, where there's very fine destruction through the conversion system of the bone.

00:10:42
Possibly requiring magnification to see, might suggest a malignant lesion.

00:10:48
Is it osteoblastic, where we have reparative or reactive bone formation, or is it mixed?

00:10:55
Number two, the bone or joint involved.

00:10:57
So some diseases affect certain bones characteristically.

00:11:01
Gout and rheumatoid arthritis usually affect the small joints of the hands and feet, while osteoarthritis will affect the knees.

00:11:09
And then the locus within a bone.

00:11:11
So certain tumors are going to arise in the diathesis, while others will occur in the physioregion or the metaphysioregion.

00:11:19

And osteoarthritis is going to affect the weight-bearing areas, the age, the gender, and the race of the patient.

00:11:28
So the age could be a risk factor for certain tumors And gender may be a risk factor for others.

00:11:34
Rheumatoid arthritis, for example may affect females more often than males, as yeas will be likely just the opposite where males are affected more often than females.

00:11:45
And then the margin of revision explanation was sharply defined or as a poorly defined A.

00:11:51
Sharply defined lesion is usually indicative of a slow-growing lesion, while a poorly defined margin of lesion is generally associated with a lesion that's more aggressive.

00:12:01
And then the shape of a lesion.

00:12:04
So if the shape is longer than wide, it's generally a slow-growing lesion.

00:12:09
And if the shape is wider than it is long, it's generally an aggressive.

00:12:15
And the joint space, is the joint space crossed, or is the joint space preserved?

00:12:21
And tumors don't usually cross the joint space or the growth space.

00:12:24
On the other hand, infections and inflammatory processes has instructions on both sides of the choice.

00:12:32
And then number eight bony reaction.

00:12:35
So periosteal reaction is characterized by interrupted for uninterrupted with interrupted suggesting some kind of malignant or aggressive lesion.

00:12:47
Uninterrupted usually suggests that benign, usually solid density kind of [UNKNOWN] The presentation of an interrupted pattern could be sunburst onion scan or the [UNKNOWN] as we saw in prior slides.

00:13:05
We could also see sclerosis or what's called I want to say we have this exostoses or osteophytes at the billing emergency.

00:13:14
Number nine matrix production, and the matrix is the tissue produced by the primary bone and neoplasms.

00:13:22
So we can have osteoid where it's bony and it appears white clouds light and fluffy density.

00:13:30
Conjoined with more cartilaginous appearing or popcorn life and then we could also have a mixed in soft tissue changes.

00:13:39
We could see that edema or haemorrhage or joint effusion displacement of fat pads or fat lines.

00:13:46
Remember the s of our ABCs, infections or inflammation, which adds density to the soft tissue.

00:13:55
Finally, a history of trauma or surgery number 11.

00:13:59
A history of pain related to activity may help differentiate between a stress fracture and a malignant bone tumor.

00:14:06
An odd bone impairment could be related to a history of surgery.

00:14:11
So, a number of different predictive variables and again, for this I'd suggest referring back to table 2 dash 4, and you are McKenna's text.

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4.6 The Radiologic Report

00:00:01
So we'll continue our discussion on general principles in radiology with lecture 4.6 here.

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00:00:11
The objectives for this portion include to describe the purposes of the radiologic report.

00:00:19
Define the 4 D's sequential tasks used in radiologist reporting.

00:00:26
Describe the components of a typical radiology report.

00:00:29
And number 4, explain two ways a physical therapist might help a patient feel more comfortable or satisfied with their imaging results.

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00:00:42
So we'll start with the radiology report.

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00:00:49
So the purposes of the radiologic report, first to link the radiologic signs with the patient history and the examination findings, and then to provide a comparison with earlier or later radiological examinations, to have a permanent record.

00:01:06
And the report supports the treatment through identified indications and contraindications for the medical intervention.

00:01:14
And the report can be used for research, and it also facilitates communication.

00:01:19
Usually, the report contains information about the patient demographics and imaging findings, and a conclusion along with the radiologist's name and signature.

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00:01:35
So the 4 Ds, radiologists are trained in the 4 Ds of radiology reporting, and they're the basic sequential tests performed when the radiologist reads a case.

00:01:47
And the 4 Ds are to detect, describe, diagnose, or differential diagnosis, and make a decision.

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[BLANK_AUDIO]

00:01:59
So the first D is detect.

00:02:00
The first thing a radiologist needs to do, and it's much improved with information in the referral about the patient's history and examination findings, associated signs, etc.

00:02:11
So this is the first task of the radiologist.

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And again, knowledge of associated signs and pathologies is essential for the radiologist to make the report more accurate.

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And so what the radiologist detects is going to be included in the findings section of the report.

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00:02:35
And then the second thing is describe, and so the findings are described clearly and concisely using medical terminology.

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It's written for the radiologist so that another radiologist can come to the same conclusion based only on the description.

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00:02:56

The third D is diagnosis or differential diagnosis, and that's the heart of the report and the answer to the clinical question that the referring provider is asking the radiologist.

00:03:06
So differentials are ordered in the most likely sequence with a maximum of 3 differentials usually.

00:03:13
And again, this is the heart of the report and it's really designed to answer the clinical question.

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[BLANK_AUDIO]

00:03:24
And finally, the fourth D is the decision, what to do next.

00:03:27
Is it important to inform others, and if so, how urgently and who to inform?

00:03:33
And is immediate communication required?

00:03:35
Are further tests recommended?

00:03:38
Are the instructions no further testing necessary appropriate for this particular case?

00:03:43
[BLANK_AUDIO]

00:03:53
So this is an example radiology report.

00:03:56
In addition to a tool for healthcare providers, radiology reports can enable patients to learn about their health, right?

00:04:03
Patients can obtain copies of their reports through an electronic portal or even a paper copy.

00:04:08
The report should be designed to increase the patient's understanding.

00:04:13

So at the top we see technique, and that's right here.

00:04:18
[BLANK_AUDIO]

00:04:27
And technique provides information about what was imaged and the type of imaging modality that was used and the information about a contrast agent, if one was present, and last one here.

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[BLANK_AUDIO]

00:04:43
The comparison in this example indicates that no prior imaging is on record to compare the study with [INAUDIBLE] here.

00:04:49
[BLANK_AUDIO]

00:04:52
The findings are where you're going to find descriptions of the areas examined by the radiologist, along with descriptions of abnormalities or normal appearance.

00:05:02
Findings may be grouped by paragraphs into the ABCs, and so the findings are right here.

00:05:08
And in this case, we have mild straightening of the lumbar spine, likely due to muscular spasm.

00:05:14
Otherwise, the alignment is maintained.

00:05:17
No evidence of acute or chronic fracture, and conus medullaris and cauda equina nerve roots are unremarkable.

00:05:24
[BLANK_AUDIO]

00:05:27
And,

00:05:28
[BLANK_AUDIO]

00:05:31

Finally, we have the conclusion at the bottom.

00:05:34
[BLANK_AUDIO]

00:05:36
And the conclusion is the area where the findings are summarized.

00:05:39
And it's also where the radiologist labels the condition and may make a diagnosis.

00:05:44
If there are multiple diagnoses, they're reported in the order of severity, starting with the most serious diagnosis.

00:05:52
So in this case, we have multilevel degenerative disk disease as detailed above, for clinical correlation.

00:05:59
[BLANK_AUDIO]

00:06:09
So radiology reports are intended for physician use, but patients may benefit from a more readable and understandable design, or someone to help them interpret the findings.

00:06:19
And so I've included this slide here, and this is from a study that demonstrates a more patient-friendly kind of approach to radiology reports.

00:06:28
So in this study, patients were much more satisfied when the results were made more understandable and medical terminology was explained.

00:06:37
Especially when the patients are able to link the locations on the imaging to the imaging text content and their current complaints.

00:06:47
By helping patients better understand the content of their results, the patients have a greater understanding of their condition and the rationale for interventions, and their satisfaction with the entire outcome is usually much higher.

00:07:01
[BLANK_AUDIO]

00:07:06
And I apologize for some of the missing text up here.

00:07:09
But one of the things to notice here is these pieces here that are underlined, for example, hypertrophy here at the L4–L5 in the image.

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This text here refers to hypertrophy, and the patient can then go over here to hypertrophy and see that hypertrophy means the enlargement of the cells.

00:07:30
Over here, down below you see disc protrusion.

00:07:34
The patient can come over here and look at disc protrusion, and you can see that the spine is intact, but bulge when one or more of this are under pressure.

00:07:44
[BLANK_AUDIO]

00:07:51
So this slide has a lot of text, but I included it to remind you that errors do occur in diagnostic radiology.

00:07:58
And this is the most widely accepted classification system and the Renfrew classification system.

00:08:05
And so there are at least 12 types of errors that occur in diagnostic radiology.

00:08:12
Some include, for example, number 10 here, type 10, failure to find a subsequent abnormality after the initial abnormality was detected.

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And we touched on this earlier, this is failure to note the second fracture.

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And so they find the first fracture and stop looking.

00:08:29
Other ones that I think that are kind of interesting here, type 5, poor communication.

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So the radiologist identifies a finding is abnormal, but that finding or that information is poorly communicated to the relevant permission, such as the physical therapist, and so that abnormal finding is not appreciated by the therapist.

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00:08:55
So Brook proposed the following classification as an alternative to the Renfrew classification, and this takes more than just human error into account.

00:09:06
So the Brook classification starts with latent errors.

00:09:10
We have an in-built system or technical faults that predispose to errors in interpretation of images.

00:09:17
And then we have active failures or human error, such as diagnostic errors and misinterpretation, or complications from procedures, and they can involve more than one person or be secondary to latent errors.

00:09:32
Then we have external causes which are beyond the control of the radiologist, such as a power failure.

00:09:37
And then customer causes which are related to the patient and non-radiology staff.

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So complying with instructions or unfamiliarity with the procedure, resulting in poor imaging outcomes.

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Another classification system is the Brook classification.

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And this is an alternative to the Renfrew classification, and it takes more than just human error into account.

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And so, for example, we have the latent errors, which are in-built system and technical faults that predispose to errors.

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Then we have active failures or human error, such as diagnostic errors and misinterpretation, or complications from procedures, usually injections.

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And then they can involve more than one person or be secondary to latent or built-in errors.

00:10:32
And then we have external causes that are beyond the control of the radiologist, such as a power failure.

00:10:37
And finally, customer causes or patient causes.

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It's related to non-radiology staff or patients, and they can include things like not complying with instructions or simply being unfamiliar with the procedure.

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And so that wraps up this lecture, and,

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00:11:01
I'd remind you to go back and take a look at those 4 Ds, and also, have a pretty basic idea of what's included in a radiology report.

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5.1 Fractures and Complications

Effects
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So this is lecture 5.1 Open and Closed Fractures and Complications.

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And objectives for this lecture include describe complications of fractures that could become life threatening and define open versus closed fracture.

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So let's start by talking about fractures from trauma.

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So imaging of musculoskeletal trauma is performed by radiography, usually X-ray.

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And the therapist should be aware of what imaging was performed at the emergency department, and this is called a primary trauma survey.

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For example, here, a primary trauma survey for a motor vehicle accident or a fall may include a cross-table lateral of the cervical spine.

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And this is to assess for gross instability, fractures, or dislocations.

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It may also include an AP view of the chest to assess for hemothorax, or pneumothorax, or pulmonary contusion.

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And it may also include an AP of the pelvis to assess for fractures or hemorrhage.

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So the primary trauma survey is a series of images to assist with screening and prioritizing patients multiple injuries.

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The goal is to avoid subjecting a trauma patient to multiple radiographic examinations and instead to quickly screen them for life-threatening injuries.

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Usually with a CT scan because the CT in the emergency department decreases assessment time and it also decreases the chance of missing a fracture.

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And it helps prioritize treatment of the patient.

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Now, some fractures can cause serious complications.

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So those are fractures which can cause a hemorrhage such as the fracture of a pelvis or the femur.

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Or fractures which can cause a fat embolism, which is a multiple crushing type injury.

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Fractures which cause neurovascular damage, which is fractures to the spine, or the elbow, or the proximal humerus.

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So although orthopedic conditions are not usually the priority in a major trauma case.

00:02:31
If there are some conditions that by themselves require urgent action to prevent serious complications.

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Fractures that can cause hemorrhage, fat embolism, or neurovascular damage, or immediate treatment.

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What is a fracture?

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A fracture is a break in the structural continuity of bone or cartilage.

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In the radiology report, fractures are described using anatomic and standardized terms.

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So eponyms such as Colles fracture or as we mentioned in one of our earlier lectures, that boxer's fracture may be used in some communications.

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But generally, these eponyms are avoided in radiologic description, because they're not descriptive enough and they can be misinterpreted.

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So here's a fractured ulna in the AP view, and you can see that here.

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And usually this fracture is due to a blow to the forearm.

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Now the image on the right is a lateral view and that reveals the head of the radius.

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Lets's see that here, and the head of the radius is displaced.

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A failure to recognize this abnormality can result in death of the radial head with subsequent elbow dysfunction.

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This illustrates the importance of always, always obtaining two views of a bone in an injury.

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00:04:02
So closed versus open fracture.

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So a fracture, as we said, is a break in the structural continuity of bone or cartilage.

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A closed fracture, the skin and the tissue overlying the fracture are intact.

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And in an open fracture, the skin is perforated or broken, so regardless of the size of the wound.

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Okay, we have that this is open fracture.

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So a basic clinical distinction in defining fractures is whether or not the fracture site is exposed to the external environment.

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In the past, the term simple and compound were used because the terms weren't used reliably simple and compound are no longer used, and diagnostic coding terminology.

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And they've been replaced with closed and open fracture.

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5.2 7 Elements of a Fracture

Effects
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So this is lecture 5.2, the 7 elements of a fracture.

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And so our objective here is to identify the 7 elements that describe a fracture.

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So the 7 elements of a fracture include, number 1, the anatomic site and the extent of the fracture, the type of the fracture, whether it's complete or incomplete, the alignment of the fracture fragments, the direction of the fracture line.

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Number 5, special features of the fracture such as impaction or avulsion.

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Number 6, associated abnormalities, such as a joint dislocation.

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And number 7, special types of fractures resulting from abnormal stress or pathological processes in the bone, such as stress fractures or pathological fractures.

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So the first element is the anatomic site and extent of the fracture.

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So bones may be referenced by standard anatomic landmarks or parts, like the surgical neck of the humerus or the intertrochanteric region of the femur, or the supracondylar area of a distal femur.

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The shaft of a long bone is divided into thirds and the junctions

between each of those regions.

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The ends of the long bones are classified as the distal and the proximal end, with each end then divided into extra-articular, the outside articular surface or outside the joint ,and the intra-articular, so within the articular surface or within the joint surface area.

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And fractures can extend from the extra-articular area to the intra-articular area.

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And so we can see in this bone diagram.

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Now, we have the extra-articular surface here and the intra-articular surface.

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And this is intra-articular because we can imagine here's the pelvis, and so this area is inside the joint.

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This is the proximal end of the femur, and then down here is the distal end of the femur.

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00:02:19
So in these images on the top, we see an intra-articular fracture, and in the bottom, we see an extra-articular fracture.

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So this is an AP view of a knee with a distal femur fracture that is intra-articular.

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The fracture extends through the intracondylar notch and the medial condyle is displaced medially and inferiorly.

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So the fracture is right through here, right, extends through the intracondylar notch, right there, and the medial condyle is displaced medially, which is that way ,and inferiorly, which is that way.

00:03:02
The bottom is a fracture of the distal femur, but this fracture does not involve the joint space and is therefore considered extra-articular.

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The fracture line is above the condyles.

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And so here we see this fracture.

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Right, and so we can also see here that the alignment,

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00:03:26
Is just off a little bit.

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So the second element of fractures, here we have the type of fracture.

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And on the left, we can see a complete fracture, and on the right is an incomplete fracture.

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So I think the takeaways here are, in a complete fracture, one bone has become two fracture fragments, right, 1, 2.

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Now, if the bone becomes more than two fragments, then the fracture is considered comminuted.

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While in an incomplete fracture, one cortical margin remains intact, and we still have one bone because only one portion of the cortex was disrupted.

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So on the right side here, we can see that this remains intact, while this side here is disrupted.

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So incomplete fractures are relatively stable, and they may maintain their position if stresses placed on them are minimized.

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So usually, incomplete fractures occur in short bones, also in irregular-shaped bones and flat bones.

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So in this image, we're looking at a complete fracture of the distal radius and an incomplete fracture of the distal ulna, okay?

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And so the distal radius here, you can see one part is here and the other part is there.

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That's a complete fracture.

00:05:08
And the ulna, we have an incomplete fracture, because look at this cortical margin, it's still intact whereas on this side, it is not intact.

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So this is a complete transverse fracture of the distal right radial metadiaphysis, with posterolateral displacement by one shaft width.

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So you can see here this,

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And shift it over by about the width of the shaft.

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00:05:44
And then there's an associated buckle fracture of the distal ulna, the slight radial angulation.

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And so that's right here, this is the buckle fracture, and you can see how the ulna sort of buckled over that way.

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00:06:01
The distal radioulnar joint alignment appears preserved, and so that's right here.

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Well, that's a mess down there, but I think you get the idea

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00:06:19
So 7 elements of a fracture, number 3 is the alignment of the fracture fragments.

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And so over here in A, we have nondisplaced.

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We have a medial displacement.

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We have a lateral displacement going this way.

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We have distracted.

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We have overriding and posterior superior displacement down here, and we have distracted and rotated.

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So alignment position is described based on the position of the distal fragment in relation to the proximal fragment.

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So non-displaced fractures have some degree of contact between the fracture fragments versus displaced fractures.

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So in these images, we're looking at complete fractures of the right radius and the ulna, and we have one shaft width of ulnar and dorsal superior displacement, and there's also 90 degrees of rotation of both fractures.

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And so the distal segment describes the alignment of the fracture, right?

00:07:37
And so this is the distal segment, and the distal fragment of ulna and radius have moved in the ulna direction.

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It may have also migrated superiorly.

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So there's one shaft width of ulna and volar displacement of the radial fracture, right?

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So that's the end of this one.

00:07:58
And there's 90 degrees of rotation of both fractures.

00:08:02
So the elbow and the elbow, we can imagine that this is going straight into the image, right, straight backwards going that way.

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The elbow and the wrist joints are oriented perpendicular to each other in this case, right?

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So if this is going straight into the page right here this is going along that way.

00:08:25
So they are perpendicular to each other in this case.

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Now, this image on the right here, that's plate and screw fixation two months later, right, so we can see the hardware.

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And a few lectures ago, we talked about how you can see, even when you

remove the hardware, you'll still be able to see some changes in the bone once that hardware is removed.

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So in the seven elements of fracture description number four, the direction of the fracture lines.

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And these are described in reference to the longitudinal axis of a long bone.

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So we have transverse here and longitudinal here and oblique here, sort of, and then spiral here, which is that.

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So the transverse is usually a result of a bending force, and it occurs at a right angle to the longitudinal axis.

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And so you have a force, for example, directed this way.

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Then a longitudinal, that force is generally parallel to the shaft of the bone.

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And the oblique, it's a diagonally oriented fracture and the result of combined compression bending and rotation.

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So you have a whole bunch of things going on in the oblique, right?

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So you have again, you have this compression.

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And you have the bending, which is probably taking place, for example

that.

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And you have some sort of rotational force.

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And finally, in spiral you have a fracture that spirals around the long axis due to a rotational force.

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So spiral and oblique can appear similar but spiral fractures have a vertical segment and sharp jagged edges.

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Spiral fractures heal more easily than oblique fractures because the fragments fit together and when they do, there's greater stability and they heal more quickly.

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So, in this image, we're looking at, on the left, an oblique fracture at the mid-diaphysis of the tibia, right here.

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And then, on the right, we're looking at a spiral fracture displaced an overlapping of the mid-femoral shaft on the right.

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So we can see here is one segment [INAUDIBLE] of the other segment.

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And so oblique fractures generally occur on a plane that's oblique to the long axis of the bone.

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And these are prone to angulation and you can see that any of the angulation and where the distal portion of the bone points off in a different direction.

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And note the sharp edges on the spiral fracture, okay, that's really sharp, and how they might fit together more easily.

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The spiral fractures are also usually the result of a high energy trauma, and often they're associated with displacement.

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So continuing with the direction of fracture lines, we have comminuted fractures.

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We can see these different versions of comminuted fractures.

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They're fractures with more than two fragments.

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And so some commonly occurring comminuted fracture patterns are on the far left.

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This is a wedge shaped or butterfly pattern in the center here, B, we have a two or three segmented level fracture, right?

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One, two, three, four.

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And then other fractures can occur with multiple fragments, be it several or several hundred, and they're still described as comminuted.

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So this slide demonstrates comminated fractures with a proximal tibia and patella.

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So we can see here an A, this is an AP radiograph of the knee and we can see fractures at the proximal tibia and patella.

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So we can see fracture fragments here, anocracy fractured by patela, all right,?

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And B we have an axial CT demonstrating fractures of the patella and the posterolateral femoral condyle.

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So we can see these fractures here, and the patella we can see multiple fractures here.

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And then finally at C we can look at this axial CT which shows comminated fractures of a proximal tibia.

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And again, we can see all these little fractures here.

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So the comminuted fractures are usually the result of extremely high energy loads, and these include crushing forces from motor vehicle accidents.

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Overall, though, in a nutshell, I think what you should take away is that a comminated fracture describes any fracture that involves more than two fragments.

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So the presence of special features number five, on the left, we have impaction.

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And on the right we have avulsion.

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And we can see in this MRI image here, this is impaction where this vertebral body has been smooshed.

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So, the special features of fractures include impaction, which is seen in A and that's a compression fracture of the vertebral body.

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And that's the result of forces related to axial loading when a bone is driven into itself.

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The other example is B which is an avulsion.

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And that's seen in this image where medial malleolar of motion occurred due to the result of an e-version force trauma at the ankle.

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And it's usually the result of tensile loading of the bone at the attachment site of a tendon ligaments, it's occurring right here.

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With the compression forces, the common areas are generally vertebral bodies here, but the other place it can occur is when we imagine the femur and,

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The tibia.

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And when the femur is driven down into the tibia, you can have, again an impaction fracture right there, along the tibial plateau.

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And so continuing with the presence of special features on the right here we are seeing an avulsion.

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And this is the lateral view of a foot that's an avulsion fracture of the calcaneal tuberosity.

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And the avulsed fragment has migrated superiorly because the now unattached tendon has recoiled, pulling that fragment with it.

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And the dotted lines indicate the normal contact areas of the fragment to the main body of the bone.

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So this attaches here, and this attaches here, and it should fit in there like a nice little puzzle piece, but it's been torn away by the tendon that attaches right there.

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So number six, associated abnormalities, subluxations and dislocations of related joints are probably the most common injuries of soft tissue associated with fracture.

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So involvement in nearby soft tissues is also common, such as disruption of the joint capsules and the ligaments and the interosseous membrane between the long bones of the forearm or the tibial fibular syndesmosis.

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So here's an example of the associated abnormalities, and this is a posterior elbow dislocation.

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And so the posterior dislocation of the elbow occurred in this 39 year old man who injured his elbow falling from a skateboard.

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And A here is a lateral view of the elbow before reduction.

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And that demonstrates the posterior position of the radius and ulna in relationship with the distal humerus, right?

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So here's the ulna and the radius, and they should be up this way.

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You can also see the fractured fragment over here.

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Now in B here and C, we can see that the fracture has been reduced and we see now better positioning of the joints, and we also see multiple fracture fragments in the soft tissue.

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And that's what these arrows are here, right?

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So fracture fragments here and down here.

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And also note the swelling of the joint and that's seen best on the lateral view because of the acute trauma.

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So that's [INAUDIBLE], and you can see how fluffy that is.

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So number 7, special types of fractures resulting from abnormal stress or pathological processes in the bones, such as stress fractures or pathological fractures.

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So stress fractures appear as a regular localized areas of more radio dense area and they represent the bones ongoing attempts at repair, right?

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So we see increased bone activity and so the image appears brighter in that area.

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The initial radiographs often appear normal, making that diagnosis difficult so there may not be evidence, for example, of a fracture line or periosteal reaction for up to six weeks.

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So we can imagine, for example, someone with a bone stress injury and they're complaining of discomfort, but we see nothing on imaging until maybe six weeks after the onset.

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And pathological fractures occur in bone that has been structurally weakened by some sort of pathological process.

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So that could be a result of osteoporosis or Paget's disease or osteogenesis imperfecta, tumor infections, disuse, etc.

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Periprosthetic fractures can also occur interoperatively or around the prosthetic components even years after surgery.

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Bone graft fractures can also occur spontaneously, even two to three years after implantation, and that may not even be related to trauma.

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The occurrence of those fractures could be as high as 40%, and this increases exponentially in plate patients with plate fixation hardware or patients who are undergoing chemotherapy.

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00:20:19
So here we're looking at a stress fracture and on the left is the calcaneus of a runner.

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And we can see the small lucency in the posterior superior calcaneal cortex.

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And this calcaneus is actually a common location of stress fracture.

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In this case, the patient had a history of overuse, having started running long distances regularly.

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And you can see that here, so we notice a break in the continuity of the cortex of this calcaneus right here.

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00:20:53
And then on the other side on the right, there's a transverse fracture of the radial shaft near the junction of the proximal and mid-thirds, so we can see that right here.

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And significant cortical thickening is seen throughout the shaft of the radius.

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And that's probably in response to the kind of training that the cheerleader's doing.

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So the stress fracture of the radial shaft in a cheerleader, this one is related to repeated full weight bearing on the hand during acrobatics or during training and performing.

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So the adaptive cortical thickening, or I should say the cortical thickening is an adaptive response to the load that's been placed through the radial shaft.

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And so that thickening here, and we can see how white, And how wide that white band is, that cortical thickening, and that predates the fracture.

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And so that cortical thickening is the bone's response to that repeated stress and that occurs with training for cheerleading.

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Okay, so in this set of two images, we're looking at stress fractures.

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And on the left is a femoral neck stress fracture in a novice runner and on the right is a severe femoral neck stress fracture and a jogger.

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On the left, we have this area of sporadic bone, this sort of white bone here, very active bone turnover, and that's seen at the base of the femoral neck.

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This is a new runner with hip pain, so that finding is generally diagnostic of a stress fracture of the femur.

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And then on the right side, we see an area of lucency, right, a darker area.

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That's right here, that's where we see that darkness.

00:22:58
Right, and that's surrounded by this sclerotic bone here.

00:23:05
And this is a jogger with hip pain and this is a severe femoral neck stress fracture on the right.

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So I'll go ahead and erase that so you can see it better again here.

00:23:17
And again, what I'd like you to take away from this is just noting this sclerotic area here, right?

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That bone is very active responding to that fracture.

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And on the left where not only do we see that sclerotic area, but we also see that linear lucency, that darker area here, this is a more severe stress fracture.

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Now this is an image of a pathological fracture, osteogenesis imperfecta.

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And this is a pathological fracture through the distal third of the olecranon in a 26 year old man as you can see by the arrows right here.

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00:24:03
And the underlying pathology here is osteogenesis imperfecta.

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And that's a disease that's characterized by abnormal maturation of collagen affecting both the intramembranous and endochondral bone

formation.

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So note the diffuse decrease in bone density.

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The very thin cortices and the flared metastases and a cystic appearance of their proximal ends of the radius of ulna.

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All right, so we can see this kind of mushroomy appearance here of the radius and maybe of ulna a little bit too, but we can also see how easy it is to see through this bone

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00:24:55
Right, just a decrease in bone density throughout here.

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Really a tragic disease.

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So, in these two images, we're looking again at pathological fracture, but these images represent the fracture as a result of metastases.

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And so these represent a pathological fracture of the femoral neck.

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And so in the image on the left A here, this is a bone scan.

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And this image reveals metastatic lesions caused by breast cancer.

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So increased uptake of the tracer is normally seen at the injection site right here, right where they inject the tracer, and also at the bladder here.

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Because that tracer is going to be excreted, but the other dark spot, it's abnormal.

00:25:53
And that represents an increased uptake of the tracer by cancerous lesion.

00:25:57
And that's right here.

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00:26:01
Okay.

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00:26:11
And so the tumor at the proximal femur weakens the bone, and as a result of that weakening, the bone is fractured here, right?

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And so, here we're looking at a periprosthetic fracture and on the left side, we're looking at a distal femur with the component intact.

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00:26:41
And,

00:26:42
[BLANK_AUDIO]

00:26:44
On the right side, we can see,

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[BLANK_AUDIO]

00:26:50
There's that fracture.

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And we can see a little bit on the left, right?

00:26:56

The component is still intact, but we can see that fracture present there.

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5.3 Fractures in Children

00:00:01
Hi, so we're continuing care with 5.3, fractures in children and the Salter-Harris classification.

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So our objectives for 5.3 are first to describe the unique patterns of injury and special problems and diagnosis treatment and healing of fractures in children.

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And then second, to define the Salter-Harris classification system.

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So fractures of children, these are complicated by features that resemble a fracture, right?

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Like growth plate for both lines, secondary centers of ossification, and then also large nutrient parameter.

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So all of the above things can be confused with fracture lines.

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And so therefore, comparison films of the uninvolved side are also very useful.

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And we mentioned this in a prior lecture.

00:00:53
I mentioned this in a prior lecture, that symmetry is really your friend when doing some of these images.

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Comparing one extremity to the other,

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An additional difficulty in radiographically examining immature bone, is that only the ossified portions of the bone have sufficient radiographic density to be imaged.

00:01:19
So the preformed cartilage is not imaged.

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00:01:26
So elements of fracture description in addition to the 7 criteria that we talked about earlier.

00:01:34
Number 8 in children are patterns of incomplete shaft fractures.

00:01:39
And number 9, which occur in children are features of fractures of the epiphysis and the epiphyseal plate.

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00:01:50
So these are patterns of incomplete fractures in children.

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So first on the left, a green stick fracture.

00:01:59
And this depicts the appearance of the incomplete fracture here.

00:02:04
And the shaft is fractured on the tension side over here whereas the cortex and the periosteum remain intact on the compression side over here.

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So next in the middle, we have the torus fracture.

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And this term is also common and describes an impaction fracture that results in the buckling of the cortex.

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So you can see this buckling here.

00:02:35
The occurs predominantly at the metaphyseal regions, which are predisposed to a compressive response because of the amount of cancellous bone and newly remodeled trabecular bone present.

00:02:48

Occasionally this kind of fracture is seen in adults if an underlying pathology exists.

00:02:55
So again, in the torus, fraction of what we're looking for is this sort of buckling right in here.

00:03:01
So plastic bowling on the far right.

00:03:04
And this is the result of the unique biomechanical nature of developing bone.

00:03:09
So when longitudinal compression forces are imposed on a naturally curved tubular growing bone.

00:03:17
And those forces exceed the point in which the bone returns to its prior position.

00:03:23
That bone becomes plastically deformed or bowed.

00:03:27
And so we've seen a few images in prior lectures where we see this sort of bowing occurring.

00:03:33
One in particular where we saw it in both the femur and the tibia of a young patient.

00:03:39
And so plastic bowing means that even when the force is removed, the bone remains bowed.

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So plastic bowing is a type of incomplete fracture because microscopic fatigue lines or microfractures are still evident in this plastically deformed bone.

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00:04:00
So, features of fractures of the epiphysis and epiphyseal plate.

00:04:05
And these are Salter-Harris classification of physio fractures.

00:04:13
And so, here's a mnemonic, Salter.

00:04:15
And so, type I is straight across.

00:04:20
Type II is above, right?

00:04:22
So if we look at the green line.

00:04:24
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00:04:26
Type II is A, and that's above type III.

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So SAL number 3 is lower or below, and you can see how it crosses through and goes below that green line.

00:04:40
And Type IV is two or through, which means it goes all the way from above, down, and through.

00:04:49
And then type V is erasure of the growth plate or a crush.

00:04:54
And so now that growth plate is gone.

00:04:59
So these Salter-Harris physio fractures, so these account for 15 to 20% of all pediatric fractures and treatment is based on an accurate diagnosis.

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And that diagnosis is critical because in addition to healing, the goal is to avoid disrupting subsequent growth.

00:05:18
So the Salter-Harris classification is used to identify the different varieties of epiphyseal fractures.

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And so again, number one is S and that's a straight across type I and 5% of fractures are type I.

00:05:35
The type two is the above and 75% of all fractures are the above type, 75%.

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00:05:48
Type III is L the lower and 10% of fractures are type III.

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So when we think about type III, we're thinking about below that green line, below that growth plate.

00:06:02
And then type IV is 2 or 3 or transverse.

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And again, 10% of these fractures are type 4, and 5 is where that growth plate is completely crushed.

00:06:11
And that's a fairly uncommon fracture occurring in 5% or less.

00:06:16
Generally, the higher the classification the greater the risk of complications and the worse the prognosis is for the patient.

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00:06:31
So in this image, again, we're looking at features of fractures of the epiphysis and epiphyseal plate.

00:06:38
And so here we're looking at this distal tibia and we have a Salter-Harris type II fracture.

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And the fracture extends through the growth plate and exits through the metaphysis.

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And this creates this triangular wedge of metaphysis that's displaced with the epiphysis.

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And so we can see.

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[BLANK_AUDIO]

00:07:00
All the way down and over, and you can see this.

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00:07:08
Wedge.

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00:07:12
Okay?

00:07:14
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00:07:23
So, in the pediatric population, the healing of fractures is divided into 3 phases, the inflammatory or acute phase, the reparative or the subacute phase, and finally, the remodeling or chronic phase.

00:07:37
And remodeling is much more extensive in an adult population.

00:07:42
And children's fractures don't always remodel with great results.

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Again, it depends on the type of fracture and how that growth plate is impacted.

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00:07:53
So that remodeling capacity is really dependent on three basic factors the skeletal age of the child the distance of the fracture site and the growth plate and then the severity of displacement of the fragments.

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5.4 Fracture Reduction

00:00:01
Okay, so welcome to Lecture 5.4, and this lecture will cover fracture reduction, open and closed fracture, external and internal.

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Not fraction, fracture, external and internal.

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So the objectives for Lecture 5.4 are to describe the differences between open reduction and closed reduction of a fracture, and describe the differences between internal and external fixation of a fracture.

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Reduction and fixation of fractures.

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Reduction is the restoration of displaced bone fragments to their normal anatomic position, and this occurs either through closed or open reduction.

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Closed reduction, no incisions are made and manipulation, traction, or both are used to guide the fragments into place.

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In open reduction, an incision is made to expose the fracture site, and after reduction the fracture fragments are kept in position through fixation.

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So during closed reductions of fractures, again, no surgical incisions are made, rather the fragments are physically guided back into position through manipulation, traction, or a combination of manipulation and traction.

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In most fractures a soft tissue pin will be present between the bone ends.

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Open reduction of fractures surgically expose the fracture site.

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Fixation is the method of maintaining fracture fragments in position after reduction in order to achieve healing.

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All fractures benefit from fixation immediately to provide pain relief, and over time to promote healing.

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00:01:55
Fixation of fractures.

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An external fixation would include a plaster cast or a splint.

00:02:02
An internal fixation includes pins, wires, plates, screws, rods, other kinds of hardware.

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ORIF stands for open reduction internal fixation.

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So an external fixation is with a plaster cast, immobilization, or a splint is used to maintain a closed reduction.

00:02:22
And open reduction uses an internal fixation, which employs orthopedic hardware or appliances such as pins, wires, plates, screws.

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And a combination of both open reduction and internal fixation is often referred to by that abbreviation, ORIF.

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00:02:47
So fixation, and here we have three types of fixation displayed on three different patients.

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In A, and we have a plaster cast on that side.

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00:03:02
And this plaster cast is immobilizing a distal radius fracture, and you can see the fracture with the arrow right here.

00:03:10
In B, we have internal fixation, and this is plate and hardware used for wrist arthrodesis.

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And this is a fusion technique to relieve pain and provide stability in patients with advanced arthritis.

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In C, we have a combination of internal and external fixation, and this is a standard uniplanar external fixator used for the treatment of a comminuted distal radius fracture.

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So the pins are anchored into the second metacarpal and the radial shaft.

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The ulnar styloid fracture is also present.

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And you see that here, that ulnar styloid fracture, we can see this, what a mess, huh?

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00:04:09
So here we have an image of a fixation, an open reduction internal fixation of the right radius.

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And this person fell from a ladder of a height of only 80 centimeters, and they came in with right elbow pain and obviously there was a fracture.

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And an ORIF was performed one day after the initial presentation.

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And so we see that fracture, dislocation of the right radius there.

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00:04:39
And the ORIF,

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00:04:44
Carried out one day after his initial trauma.

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00:04:53
So fracture healing.

00:04:55
We have cortical bone healing, cancellous bone healing, and surgically compressed and fixated bone healing.

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So cortical bone fractures heal by the formation of new bone, or callus, bridging a fractured gap.

00:05:09
Cancellous bone fractures unite with little or no callus formation.

00:05:14
Healing occurs via direct osteoblastic activity at the fracture site, also referred to as creeping substitution.

00:05:22
Surgically compressed and fixated bone heals via direct osteoblastic activity with little or no periosteal reaction or callus formation.

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00:05:39
Cortical bone healing.

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Fracture healing in cortical bone, as we see an A, a hematoma fills in the fracture site after the periosteum and the endosteum rupture.

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So we have this fracture going all the way through here and the hematoma filling it up.

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And the periosteal and endosteal response results in bone deposition that proceeds toward the fracture.

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So that's what we're seeing right here, this bone deposition, and creeping in that way.

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And in C, you can see that a collar of callus surrounds the fracture site, and this will progressively remodel over time.

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The primary callus is eventually replaced by a secondary callus.

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And this callus becomes organized in response to mechanical stresses on the bone.

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Recall the lecture earlier on Wolff's law, right, bone is going to remodel based due to the demands that are placed on it

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00:06:50
And this image is an example of cancellous bone healing.

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And this is inter-trabecular bone formation seven days after a drill hole is placed in the proximal tibia of the mouse.

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So we can imagine a drill hole right through this area, and this is seven days afterwards.

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And so we can already see some of that new bone formation.

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So cancellous bone injuries occur in vertebral compression fractures, and distal radius fractures, tibial condyle fractures, etc.

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Cancellous bone fractures unite with little or no callus formation, and instead they heal by membranous bone formation.

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Intra-trabecular bone formation occurs quickly, and healing occurs via direct osteoblastic activity at the fracture site, also referred to as creeping substitution.

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This method of healing requires that the fracture fragments be in close contact with each other.

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If approximation cannot be achieved, the hematoma fills in the gap and the healing proceeds by callus formation.

00:08:03
Cancellous bone formation is spatially restricted.

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It does not extend to more than a few millimeters outside of the injured region.

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The filling of a defective cancellous bone of a few millimeters width can therefore be slow or even incomplete.

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This is quite different from shaft fracture healing, which can fill up considerable gaps.

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So if the gap in cancellous bone during instrumented fixation or joint replacement surgery is more than a few millimeters, healing can be slow or incomplete, and rarely if it's greater than two millimeters in width.

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00:08:44
Surgically compressed bone healing.

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So fracture healing on compressed and surgically fixated bone occurs via direct osteoblastic activity with little or no periosteal reaction or callus formation.

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Immediate remodeling occurs as bone deposition and resorption continuous simultaneously as a result of osteoblastic and osteoclastic cell activity.

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So here we're looking at three images of a fracture to a 17-year-old girl.

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In image A, the fracture fragments are displaced laterally, and so we're looking here at the tibia.

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You see that displacement in the fibula, and you see that displacement.

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And B, we're seeing the formation of callus, you can see these lumps forming there, callus formation.

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And then in C, no evidence of fracture lines remain, but we do see,

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00:09:51
A residual callus formation.

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So successful healing of both fractures is what we're looking at here with these three images.

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In image A, these are emergency room films made after a sledding accident.

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And so the fracture is located at the junction of the distal and middle thirds of the shafts of the tibia and fibula.

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In both bones, the fracture fragments are overriding and displaced laterally, good alignment exists.

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In image B,

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These are follow-up films taken three weeks later.

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And the image is taken through the plaster cast and it shows formation of callus bridging the fracture gap.

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So this patient did have external fixation, she had the plaster cast.

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And C, these are follow-up films taken one year later, and they show good progression of remodeling and no evidence of the fracture lines.

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5.5 Fracture Healing

Effects
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00:00:02
Okay, so welcome to lecture 5.5, Fracture Healing, Missed Fractures, and Professional Communication.

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So, the objectives for 5.5 are to identify factors which influence the timeframe for fracture healing.

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Identify three causes of commonly missed fractures and describe the importance of professional collaboration, and communication with regards to patient outcomes.

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So we'll begin with the overlapping phases of fractured healing and the timeframe for complete fracture healing is divisable into three phases that overlap a little bit.

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The inflammation phase occupies around 10% of the total healing time, the reparative phase occupies around 40% and the remodeling phase takes up about 70% of the total healing time.

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So the vast majority of fracture healing time is dedicated to remodeling.

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So the timeframe for fracture healing is generally 4-8 weeks.

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The actual time and the process of healing is influenced by a number of factors, so we can take, for example, the distal radius,

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And the median healing time is around 5.6 weeks, so the recommended length of immobilization is around six weeks.

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On the other hand, take a look here at the scaphoid, the median healing time in weeks is around 7.7 weeks but the recommended length of a mobilization for the scaphoid is between 6 and 12 weeks.

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So quite a bit of variability and I think that's probably what I'd like you to take away from this slide.

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00:02:05
So we'll cover 12 factors that influence fracture healing, the first is the age of the patient, number two is the degree of local trauma, and the degree of bone loss and the type of bone involved.

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So, generally, the younger a patient, the more rapidly the fracture will heal.

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The greater local trauma at the fracture site and an adjacent soft tissue results in delays to fracture healing.

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More tissues involved in the injury diffuse the cellular repair effort, delaying healing and greater displacement of the fracture fragments are also known to delay fracture healing.

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The loss of bone, substance, or excessive distraction of the fragments compromises the ability of the cells to bridge that gap at the fracture site, and that also can contribute to a delay in healing.

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Cancellous bone unites rapidly, but only at points of direct contact between the bone.

00:03:01
Cortical bone unites by two mechanisms depending on the local conditions.

00:03:06

A rigid, immobilized site with contact of fragments will heal faster than a poorly immobilized site with displacement

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The next four factors that influence healing include degree of immobilization, infection, local malignancy and nonmalignant local pathological conditions.

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So inadequate immobilization leads to delayed union or even to nonunion of the bones.

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If movement persists during the repair process, a cleft or false joint, of a pseudarthrosis, can develop between the fragment ends of the bone.

00:03:48
Infection at a fracture site results in delayed or complete lack of healing because the local cell response is focused on containing or eliminating the infection, instead of healing the bone.

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Unless a malignancy is treated, fractures through a primary or secondary malignant tumor will not demonstrate meaningful healing.

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Fractures through a nonmalignant but abnormal bone may heal but in some instances such as Paget's disease or fibrous dysplasia healing may be delayed or may not even happen at all.

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00:04:27
The last four factors we're going to discuss which influence healing include radiation necrosis, avascular necrosis, hormones and exercise and local stress about the fracture.

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Bone exposed to radiation heals more slowly and may fail to unite because of cell death, vessel thrombosis and fibrosis of marrow.

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Usually bone healing occurs from both ends of the fracture site, but if one fragment is avascular, then healing must proceed from one side only, and this can delay the process.

00:05:01
If both sides have vascular disruption, then the chances of healing are very low.

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Corticosteroids are powerful inhibitors of the rate of fracture healing, and growth hormones stimulate fracture healing.

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00:05:16
Forces acting on the fracture site stimulate bone healing, but while appropriate stress to the fracture site can be beneficial unwanted motion at the fracture site can result in delayed union or even malunion.

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00:05:35
This is an image of a radial malunited fracture and ulnar fracture non-union.

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So this is an old distal owner and radio fracture in this video of graph of a 15 year old male.

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Let's see evidence of a fractured gap and bone resorption at the distal ulnar, answer here.

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00:06:04
And there's no callus formation.

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You also see this medially angulated malunited distal radius fracture, so you see this fracture it's malunited [INAUDIBLE] Again the two things to take away from this are this fractured gap here and there's evidence of bone resorption here.

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You can see how this is sort of diffuse and then the final thing to take away is this medial angulation.

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00:06:43
This is a malunited fracture mid-shaft of the right humerus with outward bowing, and you can also see osteoarthritis of the glenohumeral joint.

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So this is a 55 year old female with right arm swelling, she has a history of right arm trauma and its been ongoing for six months after a fall in the bathroom and she was treated at another hospital.

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The patient indicated that she refused surgery, and therefore the fracture was treated conservatively with an arm sling.

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This resulted in malalignment of the humerus and healing occurred in this malunited fashion.

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Malunited fractures cause mechanical changes that can lead to osteoarthritis in nearby joints.

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And so what I'd like you to see here in this image is if we look at the glenohumeral joint, you can see the lack of space, and we can also see this sclerotic change here.

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Of course, the obvious presence here is this malunion

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So if radiologic examination during fracture healing.

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The frequency of examination depends on the stability of the fracture and the need to monitor any complications.

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The least amount of radiographic monitoring is appropriate in a non-displaced, uncomplicated closed fracture immobilized in a cast.

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In this case, the patient would have initial radiographs to diagnose and direct treatment, and then no further radiographs until the cast is removed approximately six weeks later.

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And these images would be to document evidence of successful healing.

00:08:38
Displaced fractures may be radiographed frequently.

00:08:41
Also fractures that demonstrate potential alignment problems or fractures that are at risk for other complication may be imaged more frequently, even at one or two week intervals.

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00:08:58
Complications in fracture healing, there are a number of complications that can interrupt fracture healing or impact fracture healing.

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And here are some of the complications that can be related to fracture healing, threatening condition such as hemorrhage, or tetanus, complications and associated tissues such as compartment syndrome or infection.

00:09:21
Complications of bone at a fracture site such as nonunion, or malunion, or pseudarthrosis ,as we mentioned earlier, and then late-effect complications, such as complex regional pain syndrome.

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00:09:45
So continuing with complications in fracture healing, delayed union is present in any situation where a fracture fails to unite in a timeframe usually required for union.

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Although fracture healing is delayed, the process of cellular repair is present, and this will continue on to complete union, provided that the adverse factors that are delaying the union are removed, and no additional stresses are imposed.

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Causes of delayed union may be disrupted vascularity, infection, inadequate or interrupted immobilization, unsatisfactory reduction, severe local trauma, loss of bone substance, or wide distraction of fragments.

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Slow union may occur in many fractures, even when conditions are ideal.

00:10:33
Even though the rate may be slow, this may be an average rate for the given conditions, such as age or fracture site, and is therefore not pathological.

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Nonunion is failure of fracture fragments to unite and the repair process is ceased.

00:10:49
The factors contributing to delayed union if left unchecked will cause nonunion.

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00:11:04
So in this slide, we're looking at a scaphoid fracture.

00:11:07
In image A ,we can see the fracture site there.

00:11:12
And in image B, we can still see the fracture site, there's no indication of fracture healing, that fracture is still present despite the hardware.

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And in image C, you see six weeks later, there are still nonunion of the scaphoid, and you can still see this gap [UNKNOWN] here.

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00:11:41
So the fracture is, in this case, occurring through the waist of the scaphoid.

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00:11:51
In A, the arrows mark the fracture site.

00:11:53
In B right here, the fracture was internally fixated with three pins.

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And so the the film made in B was two months after the surgery.

00:12:04
And as I mentioned earlier, it shows no indication of fracture healing.

00:12:08
That radiolucent line represents the fracture site and it's unchanged from image A.

00:12:14
And so the hardware or the pins were subsequently removed.

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In image C, this follow-up film was made six weeks after the hardware removal.

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And again, as I mentioned earlier, it shows a nonunion of the scaphoid

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Complications in fracture healing can include malunion, where the fracture is united, but an angular or a rotational deformity exists.

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Recall that slide from earlier with the angulator radius.

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Pseudoarthrosis is another complication, the creation of a false joint when the ends of the bones in a nonunion become surrounded by a bursal sac.

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Osteomyelitis, a pathogen is spread from an open fracture or a surgical fixation.

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00:13:11
Pseudarthrosis or false joint is an abnormal condition at a nonunion fracture site, where a bursal sac surrounds the fracture site, and as depicted here.

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00:13:30
And this is an image of avascular necrosis where a blood supply to a bone is compromised, which then leads to bone death.

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And in this image, this is avascular necrosis of the lunate in a 25-year-old man.

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The increased density of the lunate represents the body's attempt to revascularize and produce new bone.

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And so you can see this, it's lit up and much brighter.

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00:14:00
So C is capitate, L is lunate, the S is the scaphoid, and Tq is triquetrum.

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00:14:11
So complications in fracture healing occurring in other tissues.

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Heterotopic ossification, where we have formation of bone in muscle and soft tissue.

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Myositis ossificans, when skeletal muscle is involved, and fasciitis ossificans, when fascia is involved.

00:14:29
Arterial injury, fractures and dislocations can result in vascular injury.

00:14:34
Nerve injury, usually temporary neuropraxia occurs from a nerve stretch, but serious nerve injuries usually are associated with open fractures.

00:14:44
So heterotropic ossification can occur at any age, but typically affects young adults with a clear history of local trauma or surgery.

00:14:53
The formation of heterotopic ossification after orthopedic trauma has been studied most extensively in the setting of fractures of the acetabulum and fractures of the elbow.

00:15:03
There's also a high incidence of heterotopic ossification after hip arthroplasty, hip replacement, traumatic amputations, traumatic brain injury and spinal cord injury, and severe burns.

00:15:17
Arterial injuries are associated with a small percentage of fractures.

00:15:21
Fortunately, most nerve injuries associated with fractures and dislocations are temporary, and they generally result, as I mentioned earlier, from stretching of the nerve, and these resolve spontaneously over time.

00:15:34
Many patients experience temporary paresthesia as a result of soft tissue edema.

00:15:39
This is also benign and self-limited.

00:15:41
More serious nerve injuries are associated with open fractures and penetrating injuries.

00:15:47
Fractures near the elbow and knee are most often involved, as are dislocations of the hip, knee, and shoulder.

00:15:54
Open exploration and nerve repair are often necessary in such cases.

00:15:58
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00:16:02
Suspected arterial injury in primary care Generally, we would assess distal circulation in all patients with suspected fracture or dislocation.

00:16:12
We would assess circulation as soon as possible.

00:16:15

When dislocation or fracture is accompanied by the absence of pulse and orthopedic care is not available, then we would attempt reduction.

00:16:25
So one article in particular advises primary care providers to minimize adverse outcomes of arterial injuries by following these parameters.

00:16:35
Assess distal circulation in all patients with a fracture or dislocation.

00:16:39
Slow pulse, pallor, and slow capillary refill, which is defined as more than three seconds, are signs of arterial injury.

00:16:48
Assess circulation as soon as possible before radiographic examination.

00:16:53
When dislocations and fractures are accompanied by the absence of pulse, and orthopedic care is not readily available, primary care providers should attempt reduction.

00:17:03
In many cases, the artery is kinked rather than torn.

00:17:06
If the limb is pulseless, much is to be gained and little lost by attempting reduction.

00:17:11
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00:17:15
Compartment syndrome.

00:17:16
Increased pressure within a closed space compromises circulation and tissue function, and this can result in ischemic necrosis.

00:17:25
So the signs of compartment syndrome are the 5 P's, pain, pallor, paresthesia, paralysis, and pulselessness.

00:17:33
But these are not always present.

00:17:36

A compartment syndrome is a condition in which the circulation and the function of the tissues within a closed space are compromised again by increased pressure within that space.

00:17:48
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00:17:49
The pain is generally deep and poorly localized.

00:17:53
The pallor is distal to the compartment.

00:17:56
And the paraesthesia is usually of a sensory nerve passing through the compartment.

00:18:01
Paralysis, permanent damage's likely without treatment.

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00:18:14
Life-threatening conditions include hemorrhage, and this is the most common life-threatening condition associated with a fracture.

00:18:21
Fat embolism is usually associated with multiple fractures, motor vehicle accident, crushing injury, and fat from the bone marrow enters the veins, eventually lodging an artery in the lungs.

00:18:33
Pulmonary embolism is usually related to immobilization and decreased activity associated with fracture healing, which increases the risk of venous thrombosis.

00:18:44
A minority of fractures have life-threatening consequences.

00:18:47
The key to the management of these conditions is early recognition and proper treatment.

00:18:53
Regarding hemorrhage, half of all pelvic fractures require a transfusion.

00:18:59
Closed femoral fractures can also result in severe hemorrhage.

00:19:03
A fat embolism in a single fracture is rare, but when it does occur, it is usually associated with long bone fractures in young adults, or hip fractures in the elderly.

00:19:14
Crushing type fractures allow fat from the bone marrow to enter the veins in the form of globules, which eventually lodge in one of the arteries of the lung.

00:19:23
Fat embolisms generally develops 12 hours after a fracture, but can appear up to 72 hours after a fracture.

00:19:31
Symptoms are similar to those with pulmonary embolism in the early stages.

00:19:35
Clinical signs include a fever, hypoxia, confusion, restlessness, changing neurological signs, urinary incontinence, and a particular rash across the chest and in conjunctiva.

00:19:48
The classic signs of pulmonary embolism are sudden onset of dyspnea and anxiety with or without substernal pain.

00:19:57
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00:20:00
Additional life-threatening conditions.

00:20:03
Gas gangrene is usually associated with a deep-penetrating injury and contamination with Clostridium.

00:20:09
Gas is produced from the fermentation of muscle sugars and spreads along the muscle.

00:20:14
Tetanus is usually associated with an open fracture, and it's contaminated with Clostridium tetani.

00:20:21
Infection stays in the wound, producing toxin that passes along nerves to the spinal cord.

00:20:27
Gas gangrene after a fracture is almost always associated with a deep penetrating injury to muscle.

00:20:34
The Clostridium group of organisms responsible for this condition is found in the intestinal tracts of humans and animals.

00:20:40
The risk of contamination was always present because these organisms are found everywhere, from barnyards to hospital operating rooms.

00:20:50
Initial symptoms are pain, edema, and exudate of thin dark fluid.

00:20:55
The fluid and bubbles of foul smelling gas produced from the fermentation of the muscle sugars, spread along the muscle sheaths, separating the sheath from the muscle.

00:21:05
It can be physically pressed up and down the length of the muscle.

00:21:08
The fluid is highly toxic, and the condition can rapidly progress to toxemia and death.

00:21:14
In tetanus, open fractures can also be contaminated by Clostridium tetani.

00:21:21
And this is commonly found in soil.

00:21:24
The resulting infection stays localized in the wound, and in this respect, is the opposite of the infection causing gas gangrene.

00:21:32
However, it produces toxins that are more virulent than the deadliest snake venom.

00:21:37
Within seven to ten days, the toxin gradually passes along nerves from the wound to the spinal cord, anchoring onto the motor neurons.

00:21:45
Stimulation of the motor nerves causes rigidity and convulsions.

00:21:48

The jaw muscles are involved earliest, hence the name lock jaw.

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00:21:57
So we'll talk a little bit now about commonly missed fractures.

00:22:00
And these are usually linked to failure to order radiography, failure to recognize fractures on radiograph.

00:22:08
Subtle fractures that may not be evident on initial radiograph, or presence of multiple injuries, or inadequate patient histories.

00:22:16
Fractures are not usually missed by patients.

00:22:19
Acute pain is pretty reliable.

00:22:21
Fractures are missed by clinicians, and studies indicate these errors are usually linked to one of the following factors.

00:22:28
And those are the ones that we mentioned above.

00:22:30
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00:22:34
So the importance of history and physical examination, and commonly missed fractures.

00:22:39
Patient history.

00:22:40
What's their trauma?

00:22:41
What was the mechanism of injury?

00:22:44
And the physical examination is their tenderness to palpation, the clinical prediction rules in the American College of Radiology Criteria.

00:22:52
Communication, communicating information from your patient examination to the radiologist may be crucial to helping the radiologist interpret the image without overlooking or missing important findings.

00:23:05
So, trauma usually precipitates a fracture, but sometimes the onset is insidious or unknown, such as stress fractures or bone stress injuries, and runners for osteoporosis.

00:23:17
During the physical exam, acute point tenderness to palpation over the fracture site is both a reliable perception of the patient and a reliable clinical sign of a fracture.

00:23:28
Clinical decision rules are well substantiated lists of clinical patient factors that have a strong predictive value in determining whether a patient has a fracture or not.

00:23:39
The application of clinical decision rules helps to ensure that injuries requiring definition by radiography do get image, and helps to prevent unnecessary imaging for injuries for which outcome is unaffected by imaging.

00:23:53
So essentially, we're trying to limit imaging in cases where it's not necessary, and make sure we have imaging performed in those cases where it's very likely to be meaningful.

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00:24:07
The rule of treatment in fracture management.

00:24:10
If suspicion for fracture is high and imaging is negative, treat it as a fracture, immobilize it, and re-evaluate with imaging in one to two weeks.

00:24:18
Always err on the side of caution.

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00:24:25
So if a fracture is present, it will announce itself on the follow up

radiograph by localized density changes of effective site.

00:24:34
And if a fracture's not present, the patient has only suffered a minor inconvenience.

00:24:38
The good sense of this fracture management principle avoids the detrimental possibilities of an unstabilized fracture, and the reality of malpractice actions.

00:24:47
Errors on the side of caution rarely have adverse outcomes.

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7.1 What is CT?

Effects
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[MUSIC]

00:00:11
So lecture 7, Computed Tomography, what is CT?

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So, our objectives for this lecture are to be able to explain in lay terms what CT is and then describe how CT images are created.

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And as an aside, my goal with introducing you to these different imaging modalities, is to try and give you enough information without overwhelming you with all of the tiny details.

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00:00:49
So, this is a CT machine that you might see in a typical imaging center or a hospital and this platform, here at the patient would lie on.

00:01:00
And then the platform would move the patient into the tube.

00:01:06
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00:01:10
So what is CT, well, CT is a medical imaging technique which uses x-rays to build detailed cross-sectional images of the body.

00:01:21
The picture we're looking at here is a case of polyarticular gout.

00:01:26
So this patient presented with generalized edema of the foot and ankle and there's well defined erosion of the first proximal phalangeal head medially, and we can see the green areas are crystal deposition.

00:01:42
Which is actually monosodium urate crystals and these are the agent responsible for this acute inflammatory condition that we call gout.

00:01:52
So we can see gout here on the first toe, but we can also see it on the third and the second up here, and it's even present at the midfoot and the sinus tarsi.

00:02:06
And if the image were rotated, we'd actually see it on the lateral aspect of the foot and ankle involving the lateral ankle ligament complex in this patient, like we see here.

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00:02:20
Okay, something like this.

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[BLANK_AUDIO]

00:02:24
So, how does CT work?

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00:02:28
Well, with CT, we have an x-ray emitter over here that actually rotates around a patient, and we also have a detector here with the letter D, and the green arrow.

00:02:42
And that's placed on the opposite side, and that detector picks up the image of a body section, and the beam and the detector move in synchrony, and they rotate,

00:02:55
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00:02:57
Around, and so unlike an x-ray, the detector of the CT doesn't actually produce an image.

00:03:04
Instead, it measures the transmission of x-rays through a full CT of the body and then the image of that section is taken from different angles.

00:03:13
And that allows us to retrieve that third dimension, as opposed to x-

rays where we only have two dimensions.

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So, to get those 3D images of a patient, the computer uses a bunch of mathematical algorithms and reconstructs the image using that data from the CT and that's.

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00:03:38
Sir Godfrey Hounsfield, is the gentleman who's credited with coming up with the idea for a CT scanner, and this is his sketch of the idea for the CT.

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00:03:55
So this is Mr Hounsfield in 1972 and the first CT image of the human brain was made about 50 years ago on October 1st 1971.

00:04:06
And we should notice here is the size of the scanner because it was dedicated to only scanning the head.

00:04:14
So, CT revolutionized the ability to visualize soft tissues and the guy who revolutionized it was an engineer and he was awarded the Nobel Prize in 1979.

00:04:27
And the idea for the CT came from a discussion Hounsfield had with a physician, who noted that while the x-rays were great at imaging bones, they were not so great at being able to look at soft tissues such as the brain very well.

00:04:43
So Mr. Hounsfield decided that you could look at slices of the brain using x-rays, beamed at different angles.

00:04:52
And, Hounsfield divided into consecutive slices the brain like a sliced loaf of bread, and the x-rays would be beamed through each slice of bread, once for each degree in a half circle.

00:05:05
So, 180 degrees or 180 beam slices, so, again, you imagine we have our emitter over here.

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Receptors here and slowly collecting images at different angles, and so the strength of the beam would be caught on the opposite side by the detector and more intense signals would result from stronger beams.

00:05:34
And the stronger beams would indicate that the beam signals had traveled through tissue that was less dense, while weaker signals being caught by the receptor would indicate that the beam had traveled through tissue that was more dense.

00:05:49
So, Hounsfield created an algorithm to reconstruct the image based on these layers from all of these different angles.

00:05:57
And, by working backward and using one of the fastest new computers back in the 70s, Hounsfield could calculate the value for each little box of each brain layer.

00:06:11
And so what we're looking here at are the different angles that the beams are passing through, giving us a little bit of data for each angle.

00:06:24
So the team installed a full-size CT scanner at a hospital in London on October 1, 1971.

00:06:31
They scanned their first patient who is a middle aged woman with evidence of a brain tumor in the left frontal lobe, sort of like here, this dark area.

00:06:43
So the process included about 30 minutes for the scan, and then driving across town with all these magnetic tapes with all the data on it.

00:06:52
In two and a half hours to process the data on a big mainframe computer, and then capturing the image with a polaroid camera, and then driving back all the way across town to the hospital.

00:07:06
So quite a process, so here's Hounsfield being presented with his Nobel Prize in 1979, and modern scanners are obviously much faster.

00:07:17

They provide higher resolution and most important, they do it with less radiation exposure.

00:07:22
They're even mobile CT scanners now, and there are more than 80 million CT scans taken annually in the United States.

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7.2 CT vs Conventional Radiography

00:00:01
So Lecture 7.2, [UNKNOWN] how is CT different from Conventional Radiography?

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Our objectives for this Lecture 7.2 are to identify how CT scanning data is different from standard radiographs, or x-rays.

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And describe the advantages and disadvantages of CT.

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And identify two settings in which CT is the preferred modality.

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So CT versus x-ray or conventional radiography.

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They both employ x rays, but the CT reconstructs images from multiple scans along cross-sectional slices while X rays create an image from a single scan.

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This is what we covered in the prior lecture, while we rotate the emitter and the receptor and collect images from a number of different angles, and then assemble all that data into a much more complex image.

00:01:01
So modern CT scanning, well, it used to be that the x-ray tube moved circumferentially around the patient as we saw in those early slides that I showed you.

00:01:12
We had this,

00:01:13
[BLANK_AUDIO]

00:01:18
Tube like that and the x-rays looked around like this and you had a table, right?

00:01:30
And so the circle would be completed and a number of projections would

be collected.

00:01:37
And then the table with the patient on it would advance just a little bit.

00:01:42
And a new slice would be taken and the emitter would rotate all the way around the patient, taking images from a bunch of different angles, and then the table would advance again and the process would repeat.

00:01:56
And so you have this delay between each slice.

00:02:00
Now there are what are called spiral scanners and they don't have that stop and go action.

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And instead they move continuously during the examination process.

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And this results in a slice that is an axial, but is helical, right?

00:02:16
So, instead of going around in a circle, you have a slice that goes around like that.

00:02:27
And so data is collected by a number of detector rows simultaneously and those multiple detector row scanners or what are called multislice CT or MSCT scanners.

00:02:42
They really represent a major advance in the ability to acquire large volumes of data with high accuracy and much shorter imaging times.

00:02:52
And so this is an example of a CT arthrography of the knee and orthogonal planes are employed in both CT and MRI.

00:03:01
And the imaging example here is from a CT arthrography study of the knee as I mentioned, and can see a coronal, sagittal and axial plane.

00:03:12
So as opposed to the last slide with the orthogonal planes produced by a CT, this is also a CT of the lateral left ankle.

00:03:22
And it's a three-dimensional reformatted CT image.

00:03:27
And in it, we can see the tibia, and fibula, and the peroneus longus, and brevis.

00:03:34
And here we can see the Achilles tendon and the calcaneus.

00:03:39
And with these kinds of images, you can see much more clearly how tendons might move over areas of a healed fracture, or you might be able to see subtle joint degenerative changes.

00:03:54
You could just see much more in detail than you can in some of the other kinds of radiography.

00:04:01
So some of the different forms of CT imaging include three-dimensional CT like we saw on the last slide or on the first slide with the gout.

00:04:09
Then there's a CT Myelogram and a Cone Beam CT.

00:04:14
So as the name applies, the three-dimensional CT is created by what's called volumetric scanning.

00:04:20
So you put together slices and pieces of slices, allowing body parts to be rotated on a computer screen.

00:04:27
A CT myelogram, and this is used less often over time because it requires injection of contrast material into the subarachnoid space.

00:04:36
It's useful in limited cases such as operative spinal stenosis.

00:04:42
Cone Beam CT instead of the patient moving continuously through the unit a cone beam CT gathers all the data in one sweep of the scanner using a large cone shaped X ray beam.

00:04:56
And images instead of slices then are based on one large volume of data, and scanning time is shorter with less radiation exposure.

00:05:05
And this is used most frequently in the hand and wrist, and also in dentistry.

00:05:10
So this is a CT myelogram of L4-L5, and this is taken from your McKinney's book.

00:05:16
The L4 nerve exits above the level displayed in the image, but here in the image you can see.

00:05:22
The L5 nerve root, this sort of gray area here, a little more diffuse.

00:05:28
And one of the things I'd like you to take away is that because it's a myelogram, we know that there's a substance that's been injected into here.

00:05:38
And the structures we can see here are the multifidus, and the ligamentum flavum here.

00:05:45
The capsule the preset joint here, the thecall sac with the cauda equina here.

00:05:53
We can see the inferior articular process here of L 4, and facet joint and a superior process at L 5 right there.

00:06:02
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00:06:04
Essentially though, you would get much more detail in this area with the myelogram than you would with a traditional x-ray.

00:06:14
So viewing CT images, recall PACS, Picture Archiving and Communication Systems.

00:06:21
And these digital storage systems allow the image to be stored and transferred to different locations, and the image quality is maintained.

00:06:32
And so I think the thing to really keep in mind here is that this

digital sort of system is much different than, as we mentioned in one of the earlier lectures.

00:06:41
Transferring physical copies of images, X-ray images etc., between locations much more efficient, much higher quality information.

00:06:54
So viewing CT images, the image radio densities are similar to conventional radiographs.

00:07:01
And shades of gray are going to reflect the radio density of the tissue.

00:07:06
Denser structures in CT are going to appear white or brighter, and less dense structures are going to appear dark.

00:07:14
So, as opposed to CT, in an MRI, the dense structures appear dark or black, all right?

00:07:22
So CT, dense structures appear white or bright.

00:07:25
MRI, the dense structures are going to appear dark or black.

00:07:30
And so, if we look at the image here on the right, this is a mid-sagittal CT image of the cervical spine from your McKinnis book.

00:07:41
It's an 80-year-old man with significant spinal stenosis.

00:07:45
And, if we look at the cortical bone of the posterior occiput, right, the posterior part of the skull right here, we can see it appears very bright or white.

00:07:56
And if we compare that to the CT vertebrae right here, this is gray because of the cancellous bone versus the cortical bone of number one.

00:08:06
And then the trapezius muscle 3, it's a little darker, but it's not quite as dark as the subcutaneous fat at number 4.

00:08:17

And then the air in the pharynx is black, or radiolucent right here.

00:08:25
And then the other thing to note in this picture is the width of the spinal canal is much greater at the atlantoaxial joint right here at A, when we compare it to down here at the level of C7 and B, and that's because there's a retrolisthesis at the C5, 6 and the C6, 7 arrows.

00:08:49
Get rid of that so you can see those arrows a little better, okay?

00:08:53
So that's right here, see 5, 6 and see 6, 7.

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00:09:02
So here's an image of L1 with degenerative changes and this is a transverse slice from an axial image.

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As if the patient were in a supine position with the viewer standing at the feet looking up.

00:09:17
And sagittal images are viewed from left to right, while coronal images are viewed as if the patient is facing the viewer, viewing images from front to back.

00:09:27
So, again, this is an axial slice of the L1 vertebra of an older woman with significant degenerative changes in the lumbar spine.

00:09:36
So, number 1 here is the liver and the 12th rib is on the right here in number 2, and the diaphragm here, let's see that, in number 3.

00:09:55
And then an osteophyte off the right side of the vertebral body it's present right here in 4.

00:10:05
And finally, the abdominal aorta we can see in the dashed outline over there.

00:10:10
And the left kidney in 5, right here.

00:10:15
And then finally, the spinous process here in 6.

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00:10:23
So the key thing to keep in mind here is that you're viewing this image as if the patient is supine with you standing at the feet looking towards the patient's head.

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00:10:43
For evaluating bone CT produces tremendous results, and what we're looking at here in this image on the right is narrowing of the spinal canal and intervertebral foramina at the L5-S1 joint of a patient who's complaining of right leg pain.

00:11:02
And number 1, we're looking at these sacroiliac joint right here, right, so the joint between these two surfaces.

00:11:10
Number 2 is the sacral ala, and then number 3 is hypertrophy and superior articular processes of S1, here.

00:11:20
[INAUDIBLE] And those are causing narrowing of the intervertebral foramina.

00:11:27
And number 4 is the vertebral body of S1 with large osteophytes on the lateral and posterior margins of the arrows.

00:11:36
So if we look at the contour here, you can see how it puffs out there a little bit, and puffs out there a little bit, and also puffs out here.

00:11:48
So the dotted line shows the normal outlines of the spinal canal.

00:11:54
This area should normally just be space and we can see how this vertebral body has encroached on that space.

00:12:06
This is an image of degenerative changes at the medial knee and it's a

sagittal plane CT scan through the medial compartment of a knee that has significant degenerative changes and multiple loose bodies.

00:12:21
And the loose bodies are in the posterior knee joint space.

00:12:26
And we can see that they're bright or radio dense.

00:12:29
And there's also a baker's cyst posterior to the joint here.

00:12:35
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00:12:37
And that baker cyst also contains multiple loose bodies.

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00:12:44
And in this CT image we're viewing a comminuted fracture of the left scapula.

00:12:49
And so we see posterior and anterior views of a comminuted fracture of the left scapula from a patient who is a bicyclist who fell during a race.

00:12:59
And suffered a direct impact on the scapula.

00:13:03
This fracture was actually treated conservatively.

00:13:08
So what are the limitations of CT?

00:13:12
Well, different tissues, for example, a tumor and the surrounding muscle may be assigned the same shades of gray, so they may look similar if their radio densities are similar.

00:13:23
There's also a relatively high radiation exposure from CT versus traditional radiography.

00:13:29
So the tissue type or the histological makeup is difficult to

determine from CT because tissues with similar radio densities will have similar shades of gray.

00:13:39
Even if one of the tissues is a tumor and the other one is a muscle.

00:13:43
And another meaningful concern with CT, as I mentioned, is the relatively high radiation exposure associated with it versus other kinds of imaging modalities such as radiography like X-ray, or MRI or ultrasound

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7.3 Neuroimaging

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So this is lecture 7.3 computer tomography and some MR neural imaging.

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And the objectives for this lecture are to define structural neural imaging.

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Define functional neural imaging.

00:00:19
Describe ideal use cases for CT neural imaging, and describe ideal use cases for MR neural imaging.

00:00:28
So structural imaging is examining the anatomy of the brain to diagnose pathology.

00:00:37
The physical structure and functional imaging is monitoring activity in the brain based on metabolic activity.

00:00:44
So this is used in research and to diagnose pathology that's too small to be detected via physical or structural changes.

00:00:54
When discussing CT neuroimaging and MR neuroimaging, CT versus MRI, in an acute setting, CT is the modality of choice because of the short scan time.

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MRI typically takes longer to complete a scan.

00:01:11
A head CT is the standard protocol in trauma for immediate assessment of intracranial bleeding.

00:01:17
MRI also plays a large role in detecting changes in fluid content, or ischemia, or edema, and hemorrhage.

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And it does this more accurately than a CT, again, at the expense of time.

00:01:31
So this is an image comparing CT and MRI, and you can see figure 4–15 in your McKinnis text.

00:01:39
And this axial slice is referred to as the cross.

00:01:44
And note on the MRI how the gray matter produced a lower signal intensity.

00:01:50
It's darker than the white matter, and the subcutaneous fat is white.

00:01:58
So regarding the CT exam in your McKinnis texts, please go through the six brain images from the six axial slices.

00:02:06
And they reveal the Cross, the Star, Mr. Happy, Mr. Sad, the Worms, and the Coffee Bean.

00:02:15
And this is an image of a CT without contrast showing a thrombosis in the right middle cerebral artery.

00:02:22
You can see it, right?

00:02:26
And this is an MRI 12 hours later, which demonstrates increased signal intensity, that brighter image with the dotted lines in front.

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7.4 fMRI, PET, and EEG

Effects
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00:00:02
This is lecture 74 we're going to continue with computer tomography and STEM magnetic resonance imaging functional MRI and EEG

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So our objective here is to by the end of the lecture, we should be able to explain the differences between functional fMRI, PET and EEG.

00:00:26
Including examples of use-cases, advantages and disadvantages.

00:00:32
MRI neuroimaging and it's used for a visualization of brain soft tissue.

00:00:38
One of the benefits is that there's no exposure to radiation with MRI.

00:00:42
However, it can't be used or it's difficult to use with individuals who are uncomfortable in enclosed spaces.

00:00:51
And it also can't be used in patients who have metallic implants.

00:00:56
Or who don't tolerate loud environments very well.

00:00:59
Functional MRI or fMRI.

00:01:03
This is used for localization of brain activity associated with a cognitive task or behavior.

00:01:10
However, it has limited resolution and it's really an indirect measure of brain activity.

00:01:16
Because the activity is measured via metabolic changes that are

occurring.

00:01:22
Positron emission tomography, PET.

00:01:25
This is useful for localization of brain activity associated with performing a cognitive task or behavior.

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It's silence and it tracks various metabolites such as glucose.

00:01:38
The drawback here is that there's very poor spatial resolution.

00:01:41
It requires radioactive tracers, it's very expensive.

00:01:46
It's limited to short tasks, again, due to the radiation exposure.

00:01:50
Like the fMRI, it's an indirect measure of brain activity.

00:01:56
EEG, electroencephalogram and ERP, evoked and related potentials.

00:02:03
So this is a direct recording of electrical brain activity associated with a cognitive task or behavior.

00:02:10
It's silent, non-invasive, it's low cost.

00:02:14
The brain activity can be directly as opposed to indirectly associated with an event or stimulus.

00:02:19
However, very poor spatial resolution versus fMRI and the analysis of the results that you get from an EEG can be very complex.

00:02:31
MRI based neural imaging techniques.

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We'll start with the image on the left, which is a structural MRI.

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This reveals the gross anatomical structure of the brain with high

detail, and in this case, in a sagittal view.

00:02:46
Now, just to the right of that, we have a diffusion MRI.

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This reveals the overall layout of white matter connections and pathways within the brain.

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This is referred to as tractography because we're going to be looking at tracks the color scheme corresponds to the orientation of the white matter fibers.

00:03:05
And so the green tract represents fibers extending between the front and the back of the brain.

00:03:12
Red is for fibers that run from the left to the right.

00:03:16
And blue is fibers that run along the axis from the top to the bottom of the brain.

00:03:22
And then finally over in C on the far right, we have a functional MRI.

00:03:27
And this reveals areas of the brain that are active when an individual is asked to perform a particular task.

00:03:33
[BLANK_AUDIO]

00:03:35
In this case, an individual who is congenitally blind was asked to identify a tactile pattern through touch.

00:03:43
So no areas of activation identified throughout the brain in yellow, including within the occipital cortex.

00:03:50
Which is normally associated with visual information processing and that's identified by the yellow arrow here.

00:03:57
[BLANK_AUDIO]

00:03:58
So in this image we're looking at diffusion MRI again.

00:04:02
This is white matter tractography, reconstruction and a normally sighted control subject in A and paired with an age matched individual with cerebral visual cortical visual impairment B.

00:04:16
So, in the individual on the left, individual A, the inferior longitudinal fasciculus, the superior longitudinal fasciculus, and the inferior fronto occipital fasciculus are all evident.

00:04:31
And now contrast that with the individual on the right, individual B.

00:04:36
You can see the marked reductions in each of these fasciculus is evident.

00:04:41
The color scheme represents the direction, just like we saw on the prior slide of the white outer fibers or the tracts.

00:04:52
[BLANK_AUDIO]

7.5 What is MRI

00:00:02
So, magnetic resonance imaging, what is an MRI image?

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And we discussed MRI briefly in the last section in relationship to MR neural imaging and so we'll get into a little more detail here in this lecture

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[BLANK_AUDIO]

00:00:19
So, the objective here is to describe in general how magnetic resonance images are created.

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So, this is an image created in 1976, and this is the first MRI scan of a human and it's the cross-section of a research student's finger.

00:00:37
What is MRI?

00:00:39
MRI is an imaging technology that uses a magnetic field and radio frequency signals to create cross-sectional images, and there's no exposure to ionizing radiation.

00:00:50
A key here is that biological tissues contain around 75% water, and that water can be easily detected by magnetic resonance.

00:01:02
So as opposed to X-rays, the MRI uses energy emitted from a hydrogen nuclei after they've been stimulated by radio frequency signals.

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So, radio frequency, those signals cause hydrogen nuclei to emit signals, and those signals are then converted to images by a computer.

00:01:28
So, MRI was initially called Nuclear Magnetic Resonance Imaging or NMR or NMRI, because of its early use in chemical analysis.

00:01:38
However, the nuclear part was dropped about 25 years ago because of fears that people would think that there was something radioactive involved, which there's not.

00:01:46
So, how does MRI work?

00:01:49
Well, different body tissues contain different amounts of water and the variation in water content can be used to help differentiate various organs within the body.

00:01:58
So, similar to how we discussed X-rays working with the different tissue densities attenuating the beam.

00:02:07
The MRI works because different amounts of water result in a variation in the properties of the image.

00:02:14
And we can see from this figure here, we look at gray matter, which is we'll say 85% water in this image and bone 17% water.

00:02:25
That's going to result in structures with distinctly different image properties.

00:02:34
So, the MRI machine.

00:02:36
The early MR research really revolved around the idea again that different body tissues contain different amounts of water and the variation in water content could be used to help differentiate the various organs within the body.

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And so the MRI works by passing an electrical current through these coiled wires in the machine to create a temporary magnetic field in your body.

00:03:00
And then a transmitter sends radio waves, and a receiver receives those radio waves and a computer uses those signals to make digital images of the scanned area of your body.

00:03:12
So, the patient lies down inside this magnet here, and the radio wave antenna sends signals into the body and the receiver detects the signals and then that computer converts those signals to images.

00:03:28
Here some of the basic elements of an MRI scanner, have a magnet,

gradient coils and RF coils.

00:03:37
And the computer controls the function of the gradient coils and the RF coils, and it receives and processes the signal from the RF coils, and turns that signal into an image that we can then interpret.

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7.6 Proton Alignment and Energy Release

Effects
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So, Lecture 7.6, we're going to go a little more in depth about MRIs and talk about magnetic resonance imaging and the proton alignment and energy release that eventually leads to the ability to produce images.

00:00:16
So our objectives for this lecture include being able to define longitudinal magnetization and identify the basic principles of MRI regarding the radiofrequency pulse, proton displacement, realignment, and the release of energy.

00:00:34
Principles of MRI, alignment of protons and altering that alignment.

00:00:39
The process of image acquisition begins by placing the patient in a scanner with an extremely strong magnetic field.

00:00:48
There's a slight difference between the number of protons lining up parallel with the magnetic field and the number of photons lining up in the opposite direction.

00:00:57
And this difference between the protons that line up parallel and those that line up in the opposite direction gives rise to net magnetization parallel with the external magnetic field, and that's referred to as longitudinal magnetization.

00:01:14
Pulses of radiofrequency waves are then applied at right angles to that longitudinal magnetization.

00:01:21
And these pulses of radiofrequency waves alter the alignment of the protons to a transverse plane.

00:01:28
And the energy absorbed in that process brings those protons to a higher energy state.

00:01:35
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00:01:38
So looking at the bullet points, once inside a strong magnetic field, the protons line up either in the direction of the magnetic field.

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So in this case,

00:01:47
[BLANK_AUDIO]

00:01:49
In the direction of the magnetic field, here, or in the opposite of that direction.

00:01:57
And the small difference in the number of protons aligned in these two directions is called the longitudinal magnetization.

00:02:06
And then radiofrequency waves are applied at right angles to the alignment and the pulses alter the alignment of the protons to a new plane or orientation.

00:02:18
So radiofrequency pulse sequence.

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A pulse sequence is a series of instructions that is repeated over and over to build up the data to create the magnetic resonance image.

00:02:30
The spin echo sequence is a 90-degree pulse followed by a 180-degree pulse, after which, MRI signal is acquired from the protons.

00:02:40
This is how the T1 and T2 images are created.

00:02:44
So these are different processes and they help the MRI differentiate between different tissue types and pathologies.

00:02:52
So displacement and gradual realignment of protons.

00:02:56
In this image, the protons are aligned with the main magnetic field in 1.

00:03:01
And then when a radio frequency pulse is applied at right angles, as

we see in number 2 here, this results in altered alignment of the protons, which is in 3, right?

00:03:12
So initially they were kind of going this way and then it's like this and now they're going that way.

00:03:19
And after that radiofrequency pulse stops, the protons gradually return to alignment.

00:03:25
So they move from pointing up that way, and they gradually start to rotate back down this way.

00:03:32
And as they return to alignment with the magnetic field, they emit energy, and that energy that's emitted is measured.

00:03:42
So we have the realignment of protons and decay.

00:03:45
So after that radio frequency pulse ceases, as we saw in that last slide, right?

00:03:51
In the last slide we had an alignment this way, and after the pulse stops, the alignment gradually begins to change into this direction, and the energy released as this change occurs here is measured.

00:04:09
So the energy that they absorb from that pulse is released.

00:04:12
That energy creates a current in a receiver coil.

00:04:16
And the change in current results in the data, which creates an MR image.

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7.7 T1 and T2 Weighted Images

00:00:01
So, lecture 77 and this lecture is on magnetic resonance imaging, T1 weighted and T2 weighted images.

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And I briefly mentioned these in the past lecture.

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So our objectives for this lecture include at the end, you should be able to describe how protons returning to alignment with the magnetic field create T1 and T2 images.

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Should be able to define T1-weighted and T2-weighted images, including the differences between them.

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And finally, you should be able to identify which structures on MRI sequences show different signal intensities.

00:00:40
On T1 versus T2- weighted images in general.

00:00:44
So T1 and T2, the protons returned to alignment with a magnetic field and as they do that, they release energy.

00:00:52
So the protons realign with the magnetic field.

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And as they do that they gain longitudinal magnetization, but they lose their transverse magnetization.

00:01:03
So my poor drawing skills here again, and the protons initially align that direction.

00:01:11
And as they return to their original orientation, there's this release of energy.

00:01:20
These are my energy lines as energy's released here, okay?

00:01:28
[BLANK_AUDIO]

00:01:30
So T1 recovery, the protons return to their longitudinal magnetization, right?

00:01:38
And as they do that, they lose energy.

00:01:41
Here's their energy lines again and the timing of the release of energy varies between tissues.

00:01:48
And so the faster the return to alignment with the magnetization.

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So the faster they move from here to here, the stronger the signal from the photons in that tissue.

00:02:02
So stronger.

00:02:04
[BLANK_AUDIO]

00:02:08
The signal, so the protons are turning back or realigning to orient themselves in the direction of the charge and longitudinal magnetization

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00:02:20
T2 decay, as opposed to the prior slide of T1 recovery, T2 decay is decay of transverse magnetization as the protons realign.

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So the slower the decay of the transverse magnetization, the stronger the signal that is recorded at the end of this process.

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And because much of the energy has been released by the protons, T2 images are grainier and display less spatial resolution.

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So T1-weighted images are created primarily by using data from differential proton relaxation rates and the plane longitudinal.

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[BLANK_AUDIO]

00:02:59
To the main magnetic field.

00:03:02
The T2-weighted images primarily make use of data from differential proton relaxation rates and the plain transverse to the main magnetic field.

00:03:14
[BLANK_AUDIO]

00:03:17
In other words, essentially what we're saying is how slowly do these protons realign and how reluctant are they to release the energy they stored up from being bumped by the radio frequency signal.

00:03:32
So a T1 weighted imaging and you can see table 5.1 in your McKinnis text.

00:03:37
The signal is caught early, and the tissues that rapidly recover that longitudinal magnetization create a highly intense signal.

00:03:47
So fat, for example, rapidly recovers longitudinal magnetization.

00:03:52
Tissues that recover longitudinal magnetization more slowly, create a low signal intensity like water.

00:04:00
So you should remember that fat recovers longitudinal magnetization quickly and therefore fat creates a highly intense signal on T1 imaging.

00:04:11
So T1 imaging is characterized by short time to repetition.

00:04:16
And the signal is caught early at a time when the difference in relaxation characteristics for fat and water is most noticeable, right?

00:04:24
So again remember that that's going to be highly intense on T1 and water is going to be very dark 21 days.

00:04:32

And so at that time, the tissues that rapidly recover that longitudinal magnetization such as fat, give out that high signal intensity and create a bright image.

00:04:45
And so when a short time to echo is employed, the tissues that are slow to regain that longitudinal magnetization.

00:04:53
Such as those that high water content have a really low signal intensity and those tissues appeared dark on T1-weighted images.

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So remember your T1.

00:05:04
[BLANK_AUDIO]

00:05:06
Fat is bright, that's a B.

00:05:10
[BLANK_AUDIO]

00:05:13
That's sort of a cheat.

00:05:14
And water.

00:05:15
[BLANK_AUDIO]

00:05:17
Is.

00:05:18
[BLANK_AUDIO]

00:05:20
Dark.

00:05:22
[BLANK_AUDIO]

00:05:26
So T2 weighted imaging, again, you can refer to table 5-1 in your McKinnis text, the signal is caught late in the decay and the return to alignment process.

00:05:37
So the tissues which are slowest to return to alignment, the slowest to give up the energy, those create the high signal intensity.

00:05:46
So water is slow to give up energy therefore, the T2 high intensity signals come mostly from water.

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So if we use my sort of bad drawing arrow examples again, right?

00:05:58
We have this alignment here.

00:06:01
And as that alignment changes the energy is given off here.

00:06:09
So in the T2, right?

00:06:11
We're looking at a slow change.

00:06:16
And so what we're going to see is because in the T2-weighted imaging, the signals measured really late in the decay process because it's moving really slowly.

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The tissues that are the most reluctant to give up energy are going to be selectively imaged and are going to be the brightest.

00:06:34
And so water's going to give up its energy slowly, and as a result, it's going to image with a really high signal intensity on a T2 sequence.

00:06:45
So, instead, the prior slide, fat is going to give up its energy rapidly.

00:06:55
And as a result on T2 imaging, it's burning fat.

00:06:59
It's going to give rise to a low intensity signal and show up darker.

00:07:03
So on T2 as opposed to T1, water is bright and fat, dark, okay?

00:07:21
[BLANK_AUDIO]

00:07:26
So T1 versus T2 MR imaging.

00:07:30
Fat creates a high signal intensity on T1.

00:07:34
Fat is bright on T1, and water creates a high signal intensity on T2.

00:07:40
Water is bright T2, so in the T1 image on the left here, the bone marrow gives rise to relatively high signal intensity, and the cerebrospinal fluid gives rise to low signal intensity.

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It's black in the image, and the intervertebral discs are also dark.

00:08:01
Also, note the intermediate signal intensity of the spinal cord and contrasted with the cerebrospinal fluid.

00:08:09
So, again, you can see this is dark and this is dark.

00:08:17
Okay, and you can also see that this.

00:08:20
[BLANK_AUDIO]

00:08:24
Are relatively bright compared to the disks.

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[BLANK_AUDIO]

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Now, in the T2 image on the right, the cerebrospinal fluid shows a high signal intensity.

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[BLANK_AUDIO]

00:08:40
And with the exception of the degenerated L5S1 disc, so that's here.

00:08:45

It's also a T1 image.

00:08:49
The nuclei of the intervertebral disk gives rise to fairly high signal intensity so you can see the high signal intensity disc over here.

00:09:00
Contrast that to the lower signal intensity on the T1 image it's important to note the anterior herniation of the L5-S1 disc, right?

00:09:12
So the signal intensities from the adjacent area of bone edema and the L5-S1 vertebrae are different on T1 and T2.

00:09:22
So the edema gives rise to increased signal intensity on the T2 image relative to the surrounding cancellous bone, whereas the same area in the T1 image stays dark.

00:09:36
So, essentially, if we start on the T2 image and we look at that herniated region, we can see these brighter areas here, right?

00:09:43
Which is indicative of more water content or edema.

00:09:47
However, when we look at that same area on the right.

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Because this is going to stay dark with higher water content, we have that darker area.

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[BLANK_AUDIO]

00:10:02
And this is a patient with rheumatoid arthritis, and so this is joint fluid, synovial hypertrophy, and this is fluid-filled erosions.

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And here we're looking at different muscles, we have the brachialis, triceps, and the capitulum of humerus,

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[BLANK_AUDIO]

00:10:27
And the radial head [INAUDIBLE].

00:10:34
[BLANK_AUDIO]

00:10:37
So, signal intensity is associated with inflammation and synovial hypertrophy and erosions in a patient with rheumatoid arthritis are displayed here, and the joint fluid is dark in the T1 image on the left.

00:10:53
But bright in a T2 image on the right.

00:10:55
Again, owing to that high water content.

00:10:59
The synovial hypertrophy, and the fluid-filled joint erosion also give rise to low signal when less bright areas on a T-borne image, but bright signal on T2.

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So this slice from the lateral aspect of the joint service the brachialis the triceps that could picture them of the humerus and the radial head, as I noted earlier.

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00:11:27
So here we're looking at the post laminectomy L4-5, and the top LS-4 is normal and on the bottom, the L5-S1 mortify muscle has been replaced by fat.

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And so we're looking at severe atrophy of the multifidus muscle following a laminectomy at the L4-5 level.

00:11:49
The upper slice is made at the level of the L3-4 disc showing a normal appearance of the multifidus muscle, the lower image is made at the level of the L5-S1 does.

00:12:01
And you should notice that brighter multifidi and appearance of the mortify where much of the muscle substance has been replaced by fat.

00:12:11
And so because this is a T1 image you can see that that fat is very bright.

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[BLANK_AUDIO]

00:12:25
This is a pivot shift injury, and this is a T2 image on the right side.

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And there's bone bruising, and note the high signal intensity in the posterior medial tubial plateau.

00:12:38
So this is a bone bruise in the medial tibial plateau of a young man who sustained a pivot shift injury while the knee was in a flexed position.

00:12:47
This resulted in compression of the medial side of the joint.

00:12:51
A sagittal proton density image on the left shows a slightly altered trabecular pattern.

00:12:58
In the posterior aspect of that medial tibial plateau.

00:13:02
Now the T2 weighted image shows increase signal intensity within this part of the marrow.

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00:13:24
So, this is an image of a runner with an overuse injury and on the top.

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And we're looking at a T1 image and on the bottom a T2 image.

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[BLANK_AUDIO]

00:13:34
And so the sagittal T1-weighted image top and the T2-weighted image on the bottom demonstrates how bone marrow edema is represented and the different sequences because of their T1 versus T2 imaging.

00:13:48
And the overuse injuries at the medial cuneiform, represented by the

closed arrow and the navicular, which is the open arrow of a young runner, show decreased signal intensities, or dark areas, on the T1-weighted image.

00:14:01
So, dark areas and we contrast that with the same area and the T2 image on the bottom.

00:14:11
You can see the increased signal intensity or their brightness on the fluid sensitive T2-weighted image.

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[BLANK_AUDIO]

00:14:25
T1 versus T2 summary, so T1 measures energy from structures which give up energy rapidly like fat after a radio-frequency pulse and T1 provides good anatomical detail.

00:14:39
T2 images structures which do not give up energy easily like water, and T2 is valuable for detecting inflammation.

00:14:46
So, because in T2-weighted imaging, the signal is measured late in the decay process, tissues that are most reluctant to give up energy are selectively imaged.

00:14:57
Free water is slow to give up its energy, and therefore it renders a high signal intensity on T2 sequences.

00:15:05
So, sat, which gives up its energy rapidly, gives rise to low signal on T2.

00:15:12
[BLANK_AUDIO]

00:15:19
T1 versus T2 summary continue.

00:15:24
Fluid tends to be hyper intense to everything else on T2.

00:15:28
Fat intensity can be unreliable because T2 images are sometimes manipulated and T1 images may use fat saturation to decrease signal from that.

00:15:38
Air, cortical bone, ligaments, tendons, and other dense fibrous tissues are dark on both T1 and T2.

00:15:46
T2 is valuable for detecting inflammation.

00:15:49
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8.1 Musculoskeletal Ultrasound: What is it?

Effects
00:00:00
[MUSIC]

00:00:09
So welcome to week eight, and the first lecture is on musculoskeletal ultrasound.

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So we're going to start with musculoskeletal ultrasound.

00:00:17
What is musculoskeletal ultrasound?

00:00:21
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00:00:24
So our objectives are to describe how energy is converted to sound waves and how those sound waves are transformed into an image in the process of ultrasound imaging.

00:00:35
Then we're going to identify the common equipment and functionality of the equipment used in ultrasound imaging.

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We'll discuss the difference in equipment shape and image between linear and curvilinear transducers, and describe how frequency affects ultrasound image resolution.

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00:00:55
Ultrasound imaging.

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In ultrasound imaging, images are created from sound waves which are reflective of tissues and the interfaces between tissues.

00:01:05
The origins of ultrasound imaging are in sonar.

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And sonar stands for sound navigation and ranging, which was prevalent on submarines during World War II.

00:01:16
Medical use of ultrasound began around the 1940s and 1950s with its ability to detect lumps in breast tissue.

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The diagnostic ultrasound uses the difference between the emitted and the received sound wave to allow the generation of images.

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00:01:35
So these are some examples of diagnostic ultrasound equipment.

00:01:38
And ultrasound equipment is packaged in a variety of forms from laptops, to tablets, to handheld units, as you see over here on the far right.

00:01:50
And the equipment cost can run from $5,000, upward of $100,000 depending on the scope of the things that it can do and the quality of images it can produce.

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00:02:04
So the ultrasound transducer, the images created by a linear transducer are rectangular over here.

00:02:14
And the field of view has the same diameter as the transducer.

00:02:17
All right, so here's the diameter of the transducer, here's the diameter of the field.

00:02:23
The curvilinear transducer, so this is curved, those images are angled, and the beam diverges, which results in a field of view that is wider than the transducer.

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So if we compare, again, here's the diameter of the linear transducer.

00:02:41
Here's the diameter of the curvilinear transducer, but the diameter of this image is wider.

00:02:50
So the transducer sends a ultrasound pulse into the tissues and then receives echoes back.

00:02:57
And those echoes contain spatial and contrast and intensity information.

00:03:03
The transducer head can be arranged in either a linear or a curvilinear shape.

00:03:09
Musculoskeletal ultrasound uses a linear array, while pelvic, abdominal, and deep structures such as the hip are usually better imaged with a transducer which is curvilinear.

00:03:21
So again, that linear array transducer on the left displays a longitudinal view of the anterior hip with a field of view that's narrow and is the same as the transducer itself.

00:03:34
While the curved array transducer on the right, the view widens as the distance from the transducer increases, showing not just the head of the femur, is right here, but also the neck and the proximal shaft of the femur.

00:03:52
So this produces an image of the hip where the deeper structures appear larger than the superficial structures as a result of that divergence.

00:04:02
So this slide shows some diagnostic ultrasound transducer heads.

00:04:06
And transducer heads come in different shapes and sizes and are filled with different technology that allows each head to perform various functions.

00:04:14
One head may operate at a range of frequencies that's completely different from another, allowing more clarity at greater or more superficial depths.

00:04:23
A smaller head could allow imaging of smaller structures.

00:04:26

For example, you could use it on toes or the fingers, although a larger head permits imaging of more area.

00:04:33
A convex head will provide an image that looks different than a head that is straight.

00:04:38
The other thing to keep in mind with ultrasound is that the frequencies result in different depths of imaging.

00:04:48
And high frequencies will be better for superficial structures, while low frequencies will be better for imaging deeper structures.

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00:04:59
So the ultrasound includes a pulsar and a transducer, and the pulsar produces electrical energy in waves with different frequencies.

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And those frequencies are usually in the range of 2 to 15 megahertz, and that's referred to as the base frequency.

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And so the pulsar delivers bursts of waves at this base frequency to the ultrasound transducer.

00:05:22
And between these bursts, there's nothing, but silence.

00:05:25
And the sound waves are emitted for about 1% of the examination time.

00:05:29
The transducer acts as a receiver for the reflected sound waves 99% of the time.

00:05:35
And so the transducer converts that electrical energy to sound energy.

00:05:41
And then it delivers the ultrasound to the tissues, and it receives the reflected sound energy.

00:05:47
And it converts that reflected sound energy back into electrical energy.

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00:05:56
So once that sound energy is converted back into electrical energy, the computer converts that electrical energy from the transducer to a digital one, and that's displayed as an image.

00:06:10
The signal is amplified and noise is also reduced.

00:06:13
Images are most often in grayscale, but Doppler imaging can actually use colors.

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8.2 How does Tissue Affect US Imaging

00:00:01
So welcome to lecture 8.2.

00:00:03
How does tissue affect ultrasound?

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00:00:10
So our objectives are to define ultrasound attenuation, including reflection, refraction, absorption and scattering.

00:00:19
Describe why ultrasonography is considered real-time imaging.

00:00:23
Identify some of the advantages and disadvantages of ultrasound versus MRI.

00:00:29
And define rehabilitative ultrasound imaging, RUSI.

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00:00:36
So the interaction between ultrasound and tissues.

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Some of the energy emitted by the transducer gets reflected back and some is absorbed by tissues and converted to heat energy.

00:00:48
Now, diagnostic ultrasound does not produce enough energy to cause a measurable rise in tissue temperature.

00:00:55
The energy emitted by the transducer is attenuated or offset through reflection, refraction, absorption and scattering.

00:01:05
So, this is a simplified image of ultrasound attenuation.

00:01:09
And we can see here that some of the energy that is emitted by the transducer, which is here is absorbed, some is reflected.

00:01:20
Some of that energy is then scattered, and some is refracted.

00:01:23
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00:01:25
So absorption is responsible for most of the attenuation of ultrasound.

00:01:29
And absorption is the result of intermolecular friction which converts mechanical energy of ultrasound to waves of heat.

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So similar to looking at an object underneath the water waves transmitted across an interface undergo a change in direction.

00:01:49
And that's refraction is the second one right here like light traveling from water to air.

00:01:56
And then reflection and scattering, scattering occurs when the reflecting surface is uneven.

00:02:02
Which causes less accurate localization of structures when we're doing ultrasound imaging and less signal energy.

00:02:10
Ultrasound imaging is based on reflected sound traveling from structures back to the transducer head.

00:02:17
So in the reflection scattering picture on the far right, one of the things to note here is that as this purple light comes down here and hits the structure.

00:02:27
Let's get these very lightly colored, dashed lines and those represent the scattering.

00:02:38
So why use diagnostic ultrasound?

00:02:41
Diagnostic musculoskeletal ultrasound equipment is usually portable, and sometimes it's in the form of a handheld unit as we noted before.

00:02:49
And sometimes a tablet or a cell phone, and the setup and imaging is very quick compared to other imaging modalities like an MRI.

00:02:59
So the quality of our special test isn't great.

00:03:01
And in general, the information provided by most of our orthopedic special tests can be summarized by this.

00:03:07
It is painful in this area.

00:03:10
An image of a torn ligament or tendon, or an accumulation of fluid is information that can influence decision making quite a bit.

00:03:17
Regardless of the pitfalls of over-imaging, patients we know from loads of published studies are likely to feel more satisfied with their care when they receive imaging.

00:03:28
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00:03:31
On the far side, that's what this study is showing.

00:03:35
We look at patient value and perceptions of the overall value of an ultrasound image and sort of satisfaction.

00:03:44
Most patients perceive ultrasound imaging or an image produced by an ultrasound scan as a very high value.

00:03:53
So diagnostic ultrasound strengths include, you can use tenderness during palpation to guide the placement of the transducer.

00:04:02
You can place the effective joint in a symptom provoking position.

00:04:06
We can image while resisting motion or performing a stretch.

00:04:09
You can image while testing ligament integrity, and we can image while applying traction or compression to an area.

00:04:17
So here's a clinical example of ultrasound and rehabilitation, and this patient presented with right shoulder pain, rated 6 out of 10, and manual muscle testing 3 out of 5.

00:04:31
And on day one, musculoskeletal ultrasound was completed, and then the patient was imaged again after three months of physical therapy.

00:04:39
And the imaging suggests a reduction of fluid and the patient reported a pain rating of 1 out of 10 and muscle testing improved to 4 out of 5 without reproduction of pain.

00:04:53
So some of the things that we're looking at in this image are these images.

00:04:57
Day one, this is the biceps tendon.

00:05:02
This means that this is the glenohumeral joint right here.

00:05:05
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00:05:08
And the surrounding fluid would be this black area here.

00:05:12
And then the right subscapularis tendon down here.

00:05:14
And again, I think these images are meant to sort of point out this black area of this we call it hypoechoic or more fluid filled area.

00:05:29
And then later on, so this was May 21st and on August 4th, we again see the biceps, tendon and less surrounding fluid.

00:05:39
We see the right subscapularis tendon here.

00:05:43
And again, less of that hypoechoic, that less visible area, that black sort of fluid filled area, and it's decreased in these images compared with the earlier ones.

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00:05:59
So diagnostic ultrasound does have some limitations.

00:06:03
The field of view is limited.

00:06:05
There's a relatively small area that can be viewed on the screen when compared with an MRI, which can expose an entire joint or an entire region of the body.

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There's limited penetration of the field, so we're unable to penetrate bone.

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The depth of the penetration affects the resolution as well, and deeper structures are imaged at lower resolutions than more superficial structures.

00:06:29
Finally, ultrasound imaging is very operator dependent.

00:06:33
The value of the information gained from an ultrasound is dependent primarily on the skill and knowledge of the operator.

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The motor skills involved in manipulating the probe, combined with the knowledge of anatomy and multiple planes, are going to affect the value of the image interpretation.

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So some of the benefits of ultrasound include that it's less expensive, we can examine multiple joints to tend to have better patient tolerance.

00:07:00
We can take more high resolution images as long as we're looking at more superficial structures.

00:07:05
We can guide needle placement.

00:07:07
And we can easily evaluate distal extremities such as the fingers or toes.

00:07:13
On the right here, is an image and these are two long axis views pasted together.

00:07:19
There's a complete full thickness tear of the Achilles tendon.

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00:07:25
And, what we notice here is this dark area, this sort of fluid filled areas and dark area here too.

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And the dynamic scan here also showed an absent proximal tendon movement with the patient actively Dorsey and plantar flex to their foot.

00:07:46
Compare that to this one, here's their calcaneus, you can see the things are not so intact.

00:07:55
We can see a lot of this dark region.

00:08:01
Now, what we'd like to do is compare that image from an ultrasound to an MRI.

00:08:05
And an MRI we can see that we can examine an entire joint.

00:08:09
We can assess intraarticular cartilage easily.

00:08:12
We can examine intraosseus abnormalities.

00:08:16
We can look at deep structures.

00:08:18
And this is much less operator dependent.

00:08:21
And this is an image of a healthy Achilles tendon and calcaneus, so we can see how the tendon attaches here to the calcaneus

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[BLANK_AUDIO]

00:08:34
And everything is intact, right?

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00:08:40
So here we're looking again at two long axis views pasted together, and we're looking at pre and post Achilles repair.

00:08:51
And so again in the pre, you can see these sort of gaps down here are interruptions, that integrity of the fiber.

00:09:04
And as you can see, you see this little image right here that tells us where we're imaging and the patients but so here's the calcaneus, this bright bony area.

00:09:16
And we can see when we looked at the post-op images here that the tendon shows much more continuity.

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And we can also see these areas where it's bunched together now because of the repair that we saw up here on top.

00:09:42
You see the integrity is disrupted in multiple places.

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00:09:49
And this view down here is called a panoramic view because it glues together multiple longitudinal views to create one large continuous image, right.

00:09:59
So again here's our calcaneus and now we can see here that post-op, this Achilles tendon is much more continuous versus.

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[BLANK_AUDIO]

00:10:26
And this is two months postoperatively.

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And these images are also taken two months post-op and this bottom image is from a curvilinear transducer.

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And so again if we visualize the transducer, right, we can have something.

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00:10:47
That's as this diameter, but because the transducer is convex, you get a much wider image.

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The other things to notice here are these hypoechoic regions, so these brighter regions right here.

00:11:04
Those are sutures, which are bunching up.

00:11:09
Jerry's keeping them all held together.

00:11:11
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00:11:23
Ultrasound and rehabilitation, rehabilitative ultrasound imaging or RUSI.

00:11:28
So RUSI is a procedure used by physical therapists to evaluate muscle and soft tissue during exercise and activities.

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So it's used to assist during interventions aimed at improving neuromuscular function.

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So, for example, we can view the low back muscles during stabilization exercises, and examine motion and space in the shoulder girdle during shoulder exercises.

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8.3 Transducer Orientation Affects What You See

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So lecture 83, how transducer orientation affects what you see.

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Our goal for this lecture is to be able to describe how the orientation of the transducer affects the image specifically with regard to longitudinal versus transverse orientation.

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So, a diagnostic ultrasound, this is the longitudinal or long-axis view.

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And so, the long head of the biceps tendon with a longitudinal view, you can imagine that the,

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[BLANK_AUDIO]

00:00:40
Transducer is going to be oriented this way.

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And so what we see here is the humerus, and then tendon, and then the deltoid muscle over the top of it.

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00:01:03
And if we're looking down on the patient, this is the longitudinal view, here's the transducer, like that.

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00:01:13
So this is the long axis view.

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And these are illustrations showing, how to identify the long head of the biceps tendon in the longitudinal plane, and the patient has their

arm facing anteriorly with the elbow flexed.

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And usually they're just asked to rest their hand on their lap at the palm of their hand facing upward.

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00:01:35
Okay, so the transducer head orientation right?

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Here right, this reflects the fact that this is a longitudinal view of the biceps tendon because the transducer had long axis and is parallel to the biceps tendon.

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[BLANK_AUDIO]

00:01:54
Okay, so here, this right here is a humorous.

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00:02:02
Okay, and so for a longitudinal view of the long head of the bicep tendon, the transducer is applied along the tendon, and the resulting image shows a sagittal slice of the tendon.

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And the top part of the transducer is usually represented along the left side of the image over here.

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And the right side of the image will reference the bottom part of the transducer and the longitudinal view.

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00:02:30
Okay, so again we have the humerus, and we have the tendon right here.

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00:02:38
Then over the top here we have the deltoid muscle.

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00:02:52
So, for a transverse view of the same tendon, the transducer is applied across the tendon resulting in an axial image of the tendon.

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So we can see the orientation of the transverse view here and here.

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So now we're looking straight down on the tendon,

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00:03:18
And so here is the axis that I'm on here.

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00:03:24
And so we're going to series of images that we're looking at here, number one, and here, and there's the rotator interval, right here is our humerus.

00:03:33
We can begin to see the bicipital groove and number two in here represents this area is there.

00:03:44
Now we can see much more of the bisects.

00:03:48
The bicipital groove and the biceps tendon here, box and our biceps tendon.

00:03:54
And then in number three, this is coming across right here.

00:03:59
You can see the distal biceps groove right there, and the biceps tendon right there.

00:04:06
And then finally in number four, you can now see the beginning of the biceps muscle belly, you can also see the pectoralis tendon, this white area here.

00:04:20
[BLANK_AUDIO]

00:04:23
And so we can see here, this is the transverse view, right?

00:04:27
This patient's arm going down there, the view is running

00:04:31
[BLANK_AUDIO]

00:04:33
That way, right?

00:04:35
As opposed to our longitudinal view before, there's more in this direction, okay.

00:04:44
And so again in this view, this is our humorous.

00:04:47
Here is our biceps tendon and then adulterated.

00:04:54
[BLANK_AUDIO]

00:05:02
And here's a view of a normal gastroc and soleus.

00:05:05
And on the left is a longitudinal view here, and on the right is a transverse view.

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[BLANK_AUDIO]

00:05:16
And so, the small foot on the image has a little yellow line, and this line demonstrates the orientation of the ultrasound transducer head.

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That's the orientation, so, what that tells us is that this is a longitudinal view

00:05:31
[BLANK_AUDIO]

00:05:34
The orientation, so this is a transverse view.

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[BLANK_AUDIO]

8.4 Echogenicity

00:00:02
Lecture 84, Echogenicity—Reflected Signal Amplitude.

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So the objectives for this lecture are to be able to define echogenicity and how it affects the ultrasound image, and identify which structures have the highest signal amplitude and which have low signal amplitude.

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00:00:27
So echogenicity refers to the degree to which tissues reflect sound waves.

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On the left we have a transverse image of the long head of the biceps tendon, actually, there it is.

00:00:41
[BLANK_AUDIO]

00:00:47
And the subscapularis tendon, which is here.

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[BLANK_AUDIO]

00:00:55
And the bicipital groove, which is right here, surrounding the biceps tendon on these sides.

00:01:04
And then the transverse humeral ligament, which is over here.

00:01:09
And the anterior deltoid, which is running over the top here.

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00:01:18
So a longitudinal image of the same area shows the tendon within the biceps groove, and so here we have the tendon, I'll kind of outline it

here.

00:01:34
[BLANK_AUDIO]

00:01:40
Here we have humerus, and this is the biceps groove.

00:01:44
So the important thing, I think, to take away here,

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00:01:49
Is given that we're discussing echogenicity, we're talking about how bright the images are.

00:01:55
And so we can see that the bone,

00:01:57
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00:02:00
Is,

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[BLANK_AUDIO]

00:02:03
Pretty bright here and that that same bone, it's pretty bright here.

00:02:09
And we can see that the biceps tendon is pretty bright, and we can see that the biceps tendon lying on top of that bone is pretty bright.

00:02:20
And then we compare that to the deltoid here, which is dark, and we compare that right here, it's dark.

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[BLANK_AUDIO]

00:02:30
[INAUDIBLE] of slides here,

00:02:32
[BLANK_AUDIO]

00:02:39
Right?

00:02:40
[BLANK_AUDIO]

00:02:42
You look at the bone here, see how bright it is?

00:02:45
[BLANK_AUDIO]

00:02:47
That bone, right, and you can see,

00:02:50
[BLANK_AUDIO]

00:02:52
How that deltoid muscle, a lot of it is,

00:02:55
[BLANK_AUDIO]

00:02:56
Hyperechoic.

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00:03:00
So structures that reflect a lot of energy are hyperechoic compared with their surrounding structures and structures that reflect very little energy are hypoechoic.

00:03:15
And when structures reflect no energy, they're referred to as anechoic.

00:03:19
So hyperechoic produce very bright images and waves are reflected off of hypoechoic tissues to produce really dark images.

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[BLANK_AUDIO]

00:03:32
So, at the very top we have echoic and at the very bottom we have anechoic.

00:03:37
So as we saw on the, [INAUDIBLE] right?

00:03:40
So those are hyperechoic structures, and if we recall that deltoid muscle, that's more hypoechoic.

00:03:52
[BLANK_AUDIO]

00:03:57
So, when we look at tissue appearances on musculoskeletal ultrasound, we can see that in general muscle is going to be interspersed with these dark spaces here that are hypoechoic.

00:04:10
We see bone, and bone's going to be very hyperechoic, right?

00:04:18
Very bright fluid on the other hand, it's very dark hypoechoic.

00:04:27
And then we can see tendon here, tends to be much brighter, and that's the underlying bone.

00:04:33
[BLANK_AUDIO]

00:04:37
And the ligament in between there, it's also fairly dark.

00:04:42
So, your bone is consistently going to be your brightest area, and your fluid going to consistently be your darkest areas.

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[BLANK_AUDIO]

00:05:01
And we can see that here, if we look, for example, at this bone, you can see this very bright outer shell here, like that.

00:05:14
Outer area of the bone, and on the inside, no signal from the cortical bone, and you can see that right here, where I drew these arrows.

00:05:26
[BLANK_AUDIO]

00:05:30

And so we can see that in here.

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[BLANK_AUDIO]

00:05:42
So regarding the imaging characteristics of bone, the ultrasound does not penetrate bone.

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So you have this very bright signal at the bone-soft tissue interface.

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00:05:53
And no signal is returned from the cortical bone, so the result is dark.

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00:06:04
So this is to display some of the imaging characteristics of bone and the arrows are the greater tuberosity.

00:06:12
And so we have a longitudinal view of the supraspinatus, showing the smooth cortical outline of a normal humeral head on the left.

00:06:22
[INAUDIBLE]

00:06:24
[BLANK_AUDIO]

00:06:30
And on the right, we can see these degenerative changes and a partial tear of the supraspinatus tendon.

00:06:38
So here, you can see how this is much less smooth,

00:06:44
[BLANK_AUDIO]

00:06:48
Than this side,

00:06:49

[BLANK_AUDIO]

00:06:51
Right, smooth, and not smooth.

00:06:57
[BLANK_AUDIO]

00:06:59
And then the tear in the supraspinatus is this area where we can see how it's darker in here.

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[BLANK_AUDIO]

00:07:11
All right, so we can also see in this picture, here's the deltoid.

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00:07:16
Right up here, the greater tuberosity is this lump right there, and the junction between the tendon of the supraspinatus and the muscle, which is right in there.

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00:07:41
So the normal imaging characteristics of tendons, tendons are also hyperechoic, they're bright relative to muscle.

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Now, they're not as bright as bone, but often you can see a distinct pattern of parallel fibers in a longitudinal image and a pattern of dense spotted fibers in a transverse image.

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00:08:06
And so here we're looking at a longitudinal view of an Achilles tendon on the left side and an inflamed tendon on the right side.

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And so you would note the Achilles tendon, which is this star here, all right?

00:08:21

[BLANK_AUDIO]

00:08:25
And the soleus muscle, which is the X here, and thickening and inflammatory changes at the tendon were found to correspond to the area of thickening, warmth, and tenderness on palpation of this patient.

00:08:39
And you should note the structural integrity of the tendon is maintained, although there's considerable inflammation within the superficial aspects, and the inflammation that you should see or you should be aware of here is this.

00:08:53
We talked about how fluid is dark, so we look at this pocket and it's incredibly dark compared to the other side.

00:09:01
[BLANK_AUDIO]

00:09:03
This is all pretty continuous here, these fibers going through.

00:09:08
And this, we can still see the fibers in there, right, just barely, and it's just much darker, which is indicative of fluid, which suggests inflammation.

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[BLANK_AUDIO]

00:09:24
And the imaging characteristics on ultrasound ligaments are also hyperechoic relative to muscle.

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So they're a little brighter than muscle, but again, a little darker than tendon and then darker than bone.

00:09:39
And you should again see a distinct pattern of fibers, but a little more compact than the fibers that we would see in tendons.

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00:09:49
So here we're looking at a longitudinal view of a normal anterior talofibular ligament on the left side.

00:09:57
And then the arrows indicate the fibers of the ligament extending from the fibula over here to the [UNKNOWN] over here, and you can see those fibers [INAUDIBLE] this way.

00:10:13
Now the image on the right, is a torn talofibular ligament, and the arrows indicate the disruption, but the arrowhead also points to the residual stump of a torn ligament, right, so right here.

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[BLANK_AUDIO]

00:10:30
This stump, and then we can see this sort of really dark area, again.

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00:10:48
So the characteristics of muscles on ultrasound imaging.

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Muscles are hypoechoic, so they're darker relative to the surrounding fascia or the tendons, or especially the bone.

00:11:00
And we should see fibrous bands of fascia in longitudinal views as parallel hyperechoic bands that appear brighter than the rest of the muscle.

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[BLANK_AUDIO]

00:11:13
So what that means is that you have this area where things in general are pretty dark, but within that area we should see these bright bands

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00:11:28
And so in this picture, what we're looking at on the left is a longitudinal view of a normal gluteus medius.

00:11:37
And on the right, a gluteus medius that's fibrosed.

00:11:42

The fibrosis is of unknown cause, but may be linked to degenerative changes in the hip.

00:11:47
What you should note here is the generally hyperechoic appearance of the fibrosed muscle, with prominent fiber strands compared to the somewhat hypoechoic normal muscle.

00:12:00
And so here we see on this side on the left side, you can see how it's dark.

00:12:06
And we look on the right side, we can see these really much brighter fiber strands in that muscle.

00:12:16
Note the subcutaneous fat and the fascia, and the gluteus medius and the gluteus minimus muscles.

00:12:24
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00:12:33
So the imaging characteristics of bursa.

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What we'll see is a fluid filled space, and we may see a hypoechoic line, a little bit of a brighter line, and the fluid and space don't reflect sound well, so they're dark.

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And this line is between two or more hyperechoic structures, so between bone and tendon, or between tendon and muscle.

00:12:55
And so what we're seeing here is the triceps and this is olecranon in this dark area.

00:13:06
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00:13:08
And this is a mildly inflamed olecranon bursa proximal to the elbow.

00:13:14
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00:13:20
So the imaging characteristics of cartilage.

00:13:22
We'll see a hypoechoic layer, a really dark layer, next to a hypoechoic cortical bone, and so we see in the left here, here's the bone, and then you see this dark area right up above it.

00:13:36
The thin arrows point to this cartilage, and the thick arrows point to the trochlear notch.

00:13:43
So the thick arrows point to the bone and the thin arrows point to the cartilage.

00:13:49
On this side over here is our lateral condyle and over here is our medial condyle, and then the star is a quadriceps tendon.

00:14:01
And so on the image on the left we're looking at normal cartilage, and on the right, and we're here, we're looking at severe degeneration, and that results in this lack of space here.

00:14:12
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00:14:25
And so the imaging characteristics of nerves, and this is looking from an axial point of view and they will be hypoechoic, so a little darker relative to tendon, but a little brighter or hyperechoic relative to muscle.

00:14:39
And in a longitudinal view, we'll see a striated pattern, and in a transverse view, we'll see a speckled kind of pattern.

00:14:48
And FDS here is flexed digitorum superficialis.

00:14:52
And flexor digitorium profundus, and the circle here is the median move, okay, and so we can see this sort of speckling.

00:15:06
So this is an image of the carpal tunnel with the focus on the median nerve.

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00:15:16
And so now, look at the imaging characteristics of nerve from a longitudinal view.

00:15:22
And so longitudinal scan, here on the left is a normal and on the right is a compressed median nerve.

00:15:31
And so this is the longitudinal scan of the palmar aspect of the wrist on the right, you can see a ganglion, and that's this star area here and that's deep to the flexor digitorium.

00:15:45
And the cyst displaces the tendon anteriorly and causes compression of the median nerve, and that's what the arrowheads are here, right?

00:15:54
So in this one, we can see that the median nerve is getting compressed, and look on this one, the space is much more open,

00:16:06
[BLANK_AUDIO]

00:16:10
Okay?

00:16:10
[BLANK_AUDIO]

8.5 Strengths and Limitations of MSK US

Effects
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00:00:02
So lecture five, musculoskeletal ultrasound, summary of indications and limitations.

00:00:07
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00:00:11
So our objectives for this lecture are to describe, in general, which structures tend to image hyperechoic, hypoechoic, and anechoic.

00:00:20
So which structures tend to be brighter and which tend to be darker?

00:00:25
And then we want to be able to summarize indications for musculoskeletal ultrasound, and finally identify limitations of musculoskeletal ultrasound.

00:00:34
[BLANK_AUDIO]

00:00:38
Imaging characteristics of ultrasound, normal and abnormal findings, I'd suggest you review your McKinnis book table 6.1.

00:00:47
Cortical bone, tendons, ligaments, and nerves are hyperechoic relative to their surrounding tissue.

00:00:53
And muscle, bursa, and hyaline cartilage or hypoechoic relative to their surrounding tissue, while cysts are anechoic, they're very dark.

00:01:03
So have a general idea that cortical bones, tendon, ligament, nerve are generally brighter relative to the surrounding tissue.

00:01:12
And have a general idea that muscle, bursa, hyaline cartilage tend to be darker, along with cysts.

00:01:20
[BLANK_AUDIO]

00:01:26
So a summary of indications for musculoskeletal ultrasound, bones, muscle tears, and tendon pathologies.

00:01:33
So for bones, joint effusion and synovitis, some kinds of fractures, particularly long bones, degenerative or inflammatory changes at a joint.

00:01:43
Muscle tears, including hamstring, gastric, biceps, etc.

00:01:48
Tendon pathologies such as tears, tendinosis, tenosynovitis.

00:01:53
Ultrasound can only image the cortical outline of bone, and is therefore limited when compared with CT and MRI.

00:02:01
Enthesopathy, which entails roughening of bone at the attachment of tendons or ligaments, commonly associated with degenerative or inflammatory changes can generally be viewed with ultrasound.

00:02:13
Regarding muscles, ultrasound is just as accurate as MRI, and additionally provides some intricate details of the muscles internal architecture.

00:02:21
Ultrasound is as accurate as MRI for measuring the cross-sectional area of muscles.

00:02:26
Regarding tendons, ultrasound can demonstrate the internal architecture of tendons.

00:02:32
And ultrasound clearly shows the fibers within a tendon, and can therefore reveal pathological changes that aren't easily diagnosed with MRI.

00:02:41
[BLANK_AUDIO]

00:02:46
Regarding ligamentous ruptures, mononeuropathies, ganglion cysts, and bursitis.

00:02:53
We used to look at ligamentous ruptures, median and ulnar neuropathies, ganglion cysts, and bursitis.

00:03:01
So regarding ligaments, the ultrasound imaging of ligaments rivals that of MRI, with the added advantages of a better display of fiber structure and the ability to perform stress tests during the examination process.

00:03:14
With regards to nerves, the ultrasound could demonstrate inflammation of a nerve and changes in your diameter that indicate entrapment neuropathies

00:03:22
[BLANK_AUDIO]

00:03:25
Cysts and bursa can be viewed in great detail, including debris from adjacent joints or even thickened synovial tissue.

00:03:33
[BLANK_AUDIO]

00:03:38
Some of the biggest limitations of musculoskeletal ultrasound include that it's operator dependent, and then it's largely affected by how obese a patient is.

00:03:47
Acoustic energy is lost in the tissue, and obtaining a correct focal length for ultrasound is problematic in obese patients.

00:03:57
And compared to other imaging methods, ultrasound is more operator dependent.

00:04:02
Also, structures deep to bone are not visualized, such as intra-articular ligaments and inter substance issues.

00:04:09
Ultrasound isn't cross air, making it difficult to visualize structures that are obscured by air in the lungs, or gas in the intestine.

00:04:16
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9.1 Review of Systems

Effects
00:00:00
[MUSIC]

00:00:09
Okay, so lecture 9.1, review of systems.

00:00:14
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00:00:20
So our objectives for this series of lectures includes describing how the review of systems differs from a systems review.

00:00:30
Describing strategies for determining whether a yes and answer to any checklist item is flagged and warrants physician contact.

00:00:38
And then number 3 is you should be able to describe strategies to integrate the review of systems checklists efficiently into a patient examination scheme.

00:00:49
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00:00:53
Review of systems, the review of systems provides information about all major body systems.

00:00:59
And also allows us to discover whether or not the symptoms suggest a need for referral.

00:01:06
Finally, we can incorporate a checklist of symptoms associated with each body system to identify any unusual symptoms.

00:01:14
So the systematic review of each body system provided by the review of systems can reveal symptoms related to the reason the patient is coming to see the physical therapist.

00:01:26
For example, in a patient being seen for back and leg symptoms, who also complains of urinary dysfunction or settled DISAStasia.

00:01:35

This combination would raise concern about the possible presence of cauda equina syndrome.

00:01:40
Equally important, the checklist may identify symptoms that are unrelated to the patient's chief presenting complaint.

00:01:47
But may be associated with one or more existing comorbid conditions, a disease, or adverse drug reactions.

00:01:54
Detecting these symptoms would prompt contact with the appropriate healthcare provider.

00:01:59
[BLANK_AUDIO]

00:02:04
So the review of systems is something we don't want to confuse with a systems review.

00:02:09
The systems review is a hands on procedure.

00:02:13
The review of systems does not require hands on.

00:02:15
The goal is a brief examination of cardiopulmonary status, musculoskeletal, integumentary, and neuromuscular systems.

00:02:23
[BLANK_AUDIO]

00:02:29
So, review of systems, and here I refer you to Box 9.1, the initial review of systems screening in your Boissonnault.

00:02:38
The review of systems can be included in a health history questionnaire provided to patients when they enter your clinic.

00:02:44
If a yes is marked by a patient, does that mean it's truly a red flag?

00:02:49
So a significant challenge for the physical therapist is deciding whether a positive response.

00:02:55
A yes response truly constitutes a red flag, which would require communication with another health care provider.

00:03:02
Or whether it's appropriate to simply note the presence of the finding and then to monitor it over time.

00:03:08
[BLANK_AUDIO].

00:03:15
This is an initial review of system screening and you should be familiar with this.

00:03:19
It's in your textbook in Box 9.1.

00:03:22
It's basically a collection of questions and the questions are trying to be as sensitive as possible to pick up any underlying serious medical issues.

00:03:32
[BLANK_AUDIO]

00:03:40
If there are yes responses on the patient questionnaire, then it's important to determine if that complaint is new, different, or maybe unusual for the patient.

00:03:50
Is there an explanation for the change that would decrease your concern?

00:03:54
Has the patient spoken about this complaint with their physician?

00:03:58
If they have, has the problem become worse since they spoke with their physician?

00:04:04
So if this is something new or something that's not easily explainable or it's worsened since the patient informed their physician.

00:04:11
It might be worthwhile to reach out and inform the patient's physician of this change.

00:04:16
Sometimes determining whether a yes represents a red flag can be very difficult.

00:04:21
For example, fatigue.

00:04:22
What makes fatigue a red flag when even healthy people are sometimes tired?

00:04:27
Red flag parameters may help a little, and we'll go over those.

00:04:31
[BLANK_AUDIO]

00:04:38
So when is it important that we communicate those yes responses, that information, with the patient's physician?

00:04:45
When it's something new.

00:04:47
When it's something that's not easily explainable, or when it's something that's worsened since the patient first informed their physician, as we reviewed on the last slide.

00:04:55
So if this is something new or not easily explainable, or it's worsened since the patient informed their physician.

00:05:00
It could be worthwhile to communicate this information with that patient's physician.

00:05:04
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9.2 General Health Screening and Red Flags

00:00:00
So, this is presentation 9.2, General Health Screening and Red Flags.

00:00:07
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00:00:11
Our objectives for this presentation are to be able to define the General Health screening tool.

00:00:17
Describe strategies for following up on fatigue related General Health screening questions which are marked yes.

00:00:24
Identify red flag findings, those that warrant physician contact, and those associated with fatigue.

00:00:30
And finally, we should be able to describe strategies for following up on malaise-related General Health screening questions which are marked yes.

00:00:39
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00:00:44
General Health screening, first I'd refer you to your textbook and box 9.2.

00:00:50
And the General Health screening can be useful for a first line of medical screening.

00:00:56
We can perform a broad screen of organ systems and systemic disorders.

00:01:00
If all responses are marked no, a PT then can be relatively comfortable treating the patient.

00:01:07
If a pain pattern is also unremarkable, the PT can also be pretty comfortable treating that patient.

00:01:14
The first seven items found in box 9.1 along the left column, along with malaise and mentation changes, are complaints that can result

from diseases of a number of different body systems.

00:01:26
Multi-system disorders, systemic illnesses, and adverse drug reactions.

00:01:31
Some of these symptoms, for example fatigue and malaise, are extremely vague but may be the initial manifestations of a very serious underlying illness.

00:01:40
[BLANK_AUDIO]

00:01:47
So just as we reviewed in the last lecture, if there are yes responses, it's then up to you to determine if that complaint is new, different, or unusual for the patient.

00:01:58
Is there an explanation for the change that would decrease your concern?

00:02:01
Has the patient spoken about this with their physician?

00:02:04
And if the physician has been spoken with, has the problem become worse since the time the physician became aware of it?

00:02:11
[BLANK_AUDIO]

00:02:18
So additional required information about fatigue.

00:02:21
Some of the questions you might ask the patient could include when did your fatigue begin?

00:02:27
Was it gradual onset?

00:02:29
Have you noticed other unusual symptoms like nausea, fever, or loss of weight, bilateral joint pain, or early morning stiffness?

00:02:38
The presence of the above symptoms could suggest malignancy, infection, or even rheumatic disorder.

00:02:44
Fatigue can be associated with many serious illnesses, including some psychological disorders, infections, cancers, medication use, and endocrine disorders.

00:02:55
Fatigue can be challenging to differentiate when we're trying to discern between fatigue associated with normal life versus fatigue associated with some kind of serious underlying disorder.

00:03:06
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00:03:12
So here we'll explore some red flags associated with fatigue, and you can look at your textbook, box 9.3.

00:03:19
But fatigue that interferes with the patient's ability to carry out normal activities or fatigue that lasts for more than four weeks without a clear explanation can be worrisome.

00:03:31
When you're communicating with another provider, it's important to describe the specifics of the condition, including changes in your patient's functional capacity.

00:03:39
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00:03:41
So an example may be that a patient says that up until three weeks ago, she typically worked eight to nine hours every day and then went home and helped take care of dinner and then was active until she went to bed at 11 PM.

00:03:53
Now that same patient struggles to make it through her workday.

00:03:57
She went home early from work twice this week because of her fatigue.

00:04:00
And when she comes home from work, she barely makes it through dinner and has been going to bed by 9 PM.

00:04:05
On the other hand, reports of pregnancy, new medication that is associated with fatigue, or recovery from illness may explain some of

these symptoms and decrease the likelihood of red flags.

00:04:16
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00:04:24
So this slide addresses the term malaise, which you'll find in your textbook.

00:04:28
And some of the questions to ask regarding malaise include when did your fatigue begin and was it gradual?

00:04:35
Have you noticed other unusual symptoms such as nausea, fever, loss of weight, bilateral joint pain, or early morning stiffness?

00:04:43
The presence of the above symptoms may suggest malignancy, infection, or rheumatic disorder.

00:04:48
[BLANK_AUDIO]

00:04:50
So as an aside, when reviewing the literature, there are very limited results regarding the term malaise in PubMed and UpToDate and in other differential diagnosis textbooks that I tried to look through.

00:05:03
Fatigue instead is a more common non-specific symptom.

00:05:06
And that being said, for your text, malaise is a sense of uneasiness or general discomfort, and quote, out of sorts, unquote feeling.

00:05:15
And your text notes that patients may describe this uneasiness as an intuition that something isn't right or that they're coming down with something.

00:05:23
This is different from post-exertional malaise which is an increase in severity of fatigue, weakness, dizziness, heart rate variation, temperature dysregulation following physical or cognitive exertion.

00:05:36
So again, I think it's important that you understand what malaise is.

00:05:40

But I think it's just as important that you understand that it's much more likely that you'll see the term fatigue used.

00:05:46
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9.3 Weight Loss and Nausea

00:00:00
So lecture three, Review of Symptoms, Weight Loss, and Nausea.

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00:00:09
So the objectives for this lecture, by the end you should be able to describe strategies for following up on fever, chills, and sweats related to general health screening questions.

00:00:19
You should be able to identify red flag findings associated with fever, chills, and sweats.

00:00:24
You should be able to describe strategies for following up on unexplained weight change from the general health screening questions.

00:00:32
You should be able to identify red flag findings associated with involuntary weight loss.

00:00:37
And describe strategies for following up on nausea and vomiting, and the general health screening questions which are marked yes.

00:00:43
Finally, you should be able to identify red flag findings associated with nausea and vomiting.

00:00:48
[BLANK_AUDIO]

00:00:58
Fever, Chills, and Sweats.

00:01:01
These are generally representative of systemic illnesses such as infections, cancers, and rheumatoid arthritis.

00:01:07
If fever is checked as yes on a questionnaire, then you should follow up with additional questions, such as are you currently suffering from the flu?

00:01:16
Could you have a sinus or other kind of infection?

00:01:19
You should also take the patient's temperature.

00:01:22
It's possible that a patient does have an infection but that patient may not have a fever.

00:01:27
[BLANK_AUDIO]

00:01:30
In older patients especially, infections can occur in the absence of fever.

00:01:34
Therefore, accompany conditions that may generate a fever include fatigue and myalgias, change in mental status, chills, sweats, tachycardia, confusion, and delirium.

00:01:48
[BLANK_AUDIO]

00:01:54
Red flags for fever include at least 99.5 to 101 degrees Fahrenheit for 3 weeks without discovery of a cause.

00:02:04
A patient who's traveled recently, or had a recent illness or recent infection.

00:02:09
Are there new skin lesions, new redness or edema?

00:02:13
This could be indicative of some kind of inflammatory process.

00:02:16
You should assess the heart rate, blood pressure, and respiratory rate.

00:02:20
Any abdominal tenderness may indicate appendicitis, cholecystitis, pancreatitis, or hepatitis.

00:02:28
You should communicate the temperature, the duration of the elevated temperature or fever, and any other pertinent findings with the provider.

00:02:35
[BLANK_AUDIO]

00:02:37
So three weeks of a fever should account for any self-limiting viruses.

00:02:42
102 degrees or higher indicates a more urgent likelihood of referral of communication with the physician.

00:02:48
The physical examination should include examining the skin for lesions, again looking for redness and increased temperature or edema, which might be indicative of some kind of infection or inflammatory process.

00:03:01
Consider the patient's medical history, including lymphoma, leukemia, HIV.

00:03:06
A cardiac history which might include pericarditis, endocarditis, or upper respiratory illness.

00:03:13
Also, nail beds could exhibit cyanosis.

00:03:16
[BLANK_AUDIO]

00:03:23
So, Unexplained Weight Change.

00:03:25
Involuntary weight loss is more common than weight gain.

00:03:30
It's a very sensitive but not a specific finding.

00:03:33
So, some questions you might ask include, how much weight have you lost or gained, and over how long of a period?

00:03:39
Do you know why you've lost or gained weight?

00:03:42
Have you noticed any other new symptoms?

00:03:45
If the patient has purposely changed his or her diet or increased physical activity during the time of the weight loss, then your concern can drop considerably.

00:03:53
Now there's a reason or an explanation for the weight loss.

00:03:56
Rapid weight gain is often associated with fluid retention, such as edema or ascites.

00:04:03
And this can be a manifestation of conditions such as congestive heart failure, liver or renal disease, and preeclampsia.

00:04:11
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00:04:18
Red flags associated with involuntary weight loss.

00:04:23
A 5 to 10% unexplained loss of body weight over 6 to 12 months can be considered a red flag.

00:04:31
Malignancy, diabetes, digestive disease, thyroid disease, depression may all be associated with involuntary weight loss.

00:04:39
Is the patient presenting with a cough or shortness of breath?

00:04:43
It's important to take a medical history, especially in older patients, due to polypharmacy.

00:04:48
Psychosocial factors should also be considered, including finances, or transport, limiting the ability to purchase groceries, an inability to prepare meals.

00:04:59
You should communicate changes of weight, the time period over which those changes occurred, and any other pertinent findings to the patient's physician.

00:05:07
[BLANK_AUDIO]

00:05:10
A gain of five pounds or more over a one-week period during pregnancy could be a warning sign potentially associated with preeclampsia, and you should be sure to note this.

00:05:20
An unexplained weight loss, as we noted above, is considered significant if it's greater than 5% of the usual body weight of the patient over a 6 to 12 month period.

00:05:29
And it's often indicative of a serious medical or psychological illness.

00:05:33
A slow weight decrease in the elderly is not uncommon and could be due to a lack of appetite, institutional food, disinterest in food resulting from a decreased sense of taste or smell.

00:05:45
A thorough medication history is critical, especially in elderly patients or those with chronic diseases who are on a multitude of medications.

00:05:53
A psychosocial history is also crucial, especially in the elderly population, who may not be eating due to the inability to shop for groceries because of financial or transportation problems.

00:06:03
An inability to prepare meals resulting from a functional limitation, or poorly fitting dentures or no dentures or a loss of appetite owing to depression or medications.

00:06:13
[BLANK_AUDIO]

00:06:20
Nausea and Vomiting.

00:06:21
Please look at box 9.4 in your textbook.

00:06:25
Nausea is common in normal life, and additional questions are often necessary to tease out what the cause might be.

00:06:32
Triggering events could include meals, motion, pain, etc.

00:06:36
Some questions to ask your patients include, describe your nausea, is it constant?

00:06:41
How frequent is it?

00:06:42
Are there any new or unusual symptoms?

00:06:45
Do you know why you feel nauseous?

00:06:47
Have you been vomiting?

00:06:49
Have you been vomiting without nausea?

00:06:51
How have you been treating your nausea?

00:06:54
Nausea and vomiting usually stem from GI infections but may reflect many categories or problems, including other infections.

00:07:03
Actual or functional GI obstruction, metabolic disorders, central nervous system disorders, drugs, pain, pregnancy, and psychiatric disorders.

00:07:13
Always check to see if the patient has made their physician aware of the issue.

00:07:17
[BLANK_AUDIO]

00:07:22
Red flags associated with nausea and vomiting.

00:07:26
So nausea or vomiting associated with any change in medication, including running out of running out of medication, is a red flag.

00:07:33
Vomit that is green-yellow may represent biliary colic.

00:07:37
Vomit that is bile-colored may be related to intestinal obstruction.

00:07:41
Vomit that appears like coffee-grounds could contain blood.

00:07:44
Make sure again to communicate the onset, the frequency, vitals, presence and nature of the vomit, and any changes in medication.

00:07:54
And have the patient rate the severity of their nausea on a scale through 0 to 10 when you communicate the findings to the physician.

00:08:00
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9.4 Strategies in Response to the General Health Screening

00:00:01
Lecture 9 for strategies in response to the general health screening

00:00:06
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00:00:09
.Objectives, by the end of this lecture you should be able to describe strategies for following up on paresthesia numbness, or weakness-related general health screening questions.

00:00:23
You should be able to identify red flag findings, those that weren't physician contact associated with paresthesia, numbness or weakness.

00:00:32
You should describe strategies for following up on dizziness and lightheadedness, you should be able to identify red flag findings that weren't physician contact associated with dizziness and lightheadedness.

00:00:44
You should be able to describe strategies for following up on changes in mental status.

00:00:48
And finally, you should be able to identify red flag findings that warrant physician contact associated with change in mental status.

00:00:55
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00:01:02
Paresthesia, numbness, or weakness.

00:01:05
Other conditions besides neurological disorders can present as paresthesia, numbness or weakness, so you might ask a patient have you experienced any changes in sensation or strength?

00:01:17
If they have are those changes associated with specific activities, what's the distribution of the numbness or weakness, are there any associated balance deficits?

00:01:27
Any changes in vision, taste, smell, or hearing.

00:01:30
Many patients report weakness, but much like fatigue, this finding is often not a red flag.

00:01:37
If a patient tells you my back feels weak or my knee gives out, these are examples of comments that would require additional questioning to figure out whether there is a serious neurological issue.

00:01:49
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00:01:50
History should include the type of weakness whether it's proximal weakness which might alert you to thyroid disease or malignancy or maybe even adrenal dysfunction, or distal weakness.

00:02:00
Which would raise an index of sufficient for neurological cause, especially if it was accompanied by paresthesia.

00:02:06
[BLANK_AUDIO]

00:02:13
Red flags associated with paresthesia, numbness, or weakness, progressive sensory or strength deficits, so changes in sensation or strength over time.

00:02:25
Saddle anesthesia change in bowel or bladder function, glove and stocking distribution of sensation loss, combination upper and lower extremity alteration of sensory and/or motor performance.

00:02:39
Again, you should communicate to the physician the onset of the symptoms, the frequency, the presence and nature of altered sensation or motor function.

00:02:47
And any other pertinent physical examination findings.

00:02:51
Chronic renal failure, multiple sclerosis, hypothyroidism, and adverse drug events are examples of disorders that could present with these findings.

00:02:59
Any subjective complaints of numbness or tingling require further investigation.

00:03:05
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00:03:09
Dizziness and lightheadedness, please see box 9.5 in your textbook, your patient may present a complaint of feeling light-headed or faint.

00:03:25
These sensations may be associated with various systems or even adverse drug reactions, you might ask your patient if they're feeling light-headed or if they notice spinning sensation.

00:03:35
And if they do, is that sensation associated with any certain position or movement?

00:03:40
You could ask your patient if they've fallen because of these symptoms.

00:03:44
Are the symptoms associated with nausea, vomiting, changes in hearing or vision, hemiparesis or even vital signs?

00:03:51
Patients interpret dizziness differently, therefore, it's important to differentiate vertigo, which is a spinning sensation, vestibular disturbance, middle ear disturbance.

00:03:59
Or even a cerebellar disturbance, dysfunction, and differentiate that from lightheadedness, which is generally associated with dehydration, hypotension, hypo or hyperglycemia.

00:04:11
Heart block infection, cardiovascular or cerebellar confusion.

00:04:17
For certain types of disorders causing dizziness, PT management should be the primary treatment, whereas other causes will require a physician management.

00:04:26
You should examine vital signs, heart and lung sounds, and incorporate special tests related to dizziness.

00:04:32
Such as the Dix-Hallpike maneuver and Romberg tests, because these can help aid diagnosis.

00:04:38
Differentiate from vestibular disorders and Meniere's disease, vertebrobasilar insufficiency may be associated with visual disturbance for hemiparesis along with dizziness.

00:04:48
[BLANK_AUDIO]

00:04:54
Dizziness and lightheadedness, so a patient may describe near fainting or fainting, they may present with slurred speech, numbness of their face or limbs, visual changes, particularly diplopia.

00:05:08
It can be an acute onset associated with nausea or vomiting.

00:05:12
[BLANK_AUDIO]

00:05:13
You should communicate findings again related to the onset, the frequency, the neurological, and the physical exam findings.

00:05:22
Dizziness can be a precursor to seizures, closer investigation is warranted if dizziness has become more frequent or if the dizziness has been lasting for longer, as this may be a pre-cursor in stroke.

00:05:34
A history of head or ear trauma should be determined, along with a history of infections and a review of medications.

00:05:41
Or recreational history including things like scuba or skydiving, high altitude hiking air travel, or even dehydration from exercise to be investigated.

00:05:51
Alcohol and substance abuse as well as anxiety or panic attacks should also be investigated.

00:05:57
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00:06:04
Changes in mental status a patient may present with confusion, or disorientation, and that can be related to many different disorders.

00:06:11

[BLANK_AUDIO]

00:06:12
Has the patient or the patient's family noticed these difficulties?

00:06:15
You might ask, when did you first note the change, do you know the cause, was the onset slow or gradual, have you noticed any other new problems associated with this onset?

00:06:26
The onset of confusion or disorientation or worsening of the symptoms can be a manifestation of multiple different disorders.

00:06:34
The cause of mental status changes include, but are not limited to Alzheimer's disease, multi-infarct dementia, stroke, central nervous system infections.

00:06:44
Neurodegenerative disorders, head Injury lesions metabolic disorders and hydrocephalus among others.

00:06:51
[BLANK_AUDIO]

00:06:57
Changing mental status observations.

00:07:00
Do you notice a change in your level of consciousness, changing your patients attention or ability to focus changes in a patient's memory, their long or their short-term.

00:07:10
Changes in the patient's orientation in terms of their ability to recognize person, place and time, change in their ability to process thoughts logically, or any changes in your patients judgments.

00:07:21
[BLANK_AUDIO]

00:07:26
If you suspect confusion or disorientation during the history, make observations including those that I just mentioned, and it may be important to share those observations not only with the patient.

00:07:36
But with the caregiver or family, and ask if the caregiver or family has noticed these difficulties.

00:07:42
The neurological examination should focus on assessment of cognition and assessment of mental status by using the mental state examination or another validated screening instrument.

00:07:58
[BLANK_AUDIO]

00:07:59
Changes in mental status, acute changes could be associated with fever, a stiff neck, or a headache.

00:08:07
[BLANK_AUDIO]

00:08:10
Acute changes in the elderly, are notable if they're associated with an infection, or a urinary tract infection, acute changes may also be associated with head trauma.

00:08:20
Progressive changes that may be associated with changes in gait, or incontinence, gradual, but meaningful changes in mental status are also of note, communicate to the physician.

00:08:30
Altered mentation and confusion are such general terms, the onus is on the PT to be as specific as possible in collecting these data and communicate these concerns to a physician

00:08:40
[BLANK_AUDIO]

00:08:45
You should use of valid and reliable tests and measures, will make communication with the physician much more effective.

00:08:56
[BLANK_AUDIO]

9.5 Upper Body Symptoms

Effects
00:00:00
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00:00:02
Lecture 9.5, we're going to begin to talk about upper body symptoms.

00:00:06
[BLANK_AUDIO]

00:00:11
By the end of the lecture, you should be able to describe strategies for following up on dyspnea, palpitations, syncope, cardiovascular related pain.

00:00:21
And you should be able to identify red flag findings associated with chest pain or chest pressure.

00:00:27
[BLANK_AUDIO]

00:00:33
The general health checklist I'd like you to look at box 9.1 and 9.6 as well as table 9.2 in your textbook.

00:00:41
And then note the overlap between cardiovascular, peripheral vascular and pulmonary systems.

00:00:47
Some items listed in box 9.1, including dyspnea, cough and palpitations, overlap with the checklist for the cardiovascular peripheral vascular and pulmonary systems.

00:00:59
[BLANK_AUDIO]

00:01:08
Dyspnea is the subjective sensation of difficulty breathing.

00:01:12
This could be related to activity, exertion or body position.

00:01:17
You might ask your patient when did the shortness of breath begin?

00:01:19

Was the onset sudden or did it occur over time?

00:01:23
Did you wake suddenly at night with shortness of breath?

00:01:25
Is the shortness of breath constant?

00:01:28
Does your shortness of breath occur with exertion?

00:01:31
Does it occur at rest, or does it occur in certain positions?

00:01:35
Dyspnea, or shortness of breath, has many causes including cardiac or pulmonary disease, as well as anxiety, obesity, and anemia.

00:01:45
Patients with a cardiac cause may also complain of increased symptoms with exertion and symptoms or dyspnea that wake them up at night and are relieved by sitting up.

00:01:54
[BLANK_AUDIO]

00:01:58
PND, paroxysmal nocturnal dyspnea, is one of the early signs of heart failure and therefore is more specific for cardiac disease.

00:02:08
Dyspnea caused by cardiac disease results most commonly from left ventricular dysfunction and or valvular disease.

00:02:16
Typically, difficulty with breathing would be associated with activity or exertion.

00:02:21
So if you ask about dyspnea only in this context, patients may not volunteer that they get short of breath when they lie down.

00:02:28
[BLANK_AUDIO]

00:02:36
Palpitations are an awareness of forceful rapid or irregular beating of the heart.

00:02:41

Occasional palpitations occur in most of the population.

00:02:44
Palpitations may be described as uncomfortable sensations in the chest and they may be associated with arrhythmias.

00:02:51
Your patient may describe palpitations as fluttering, jumping, pounding, irregularity, or feeling like their heart is skipping a beat.

00:03:01
You should ask your patient about their frequency, the duration, and any associated symptoms.

00:03:06
You should also ask your patient about any history of heart disease, myocardial infarction, heart attack, or valvular heart disease.

00:03:15
Occasional palpitations occur physiologically and the majority of the population.

00:03:21
Or in some people as a result of other non cardiac conditions such as anxiety, panic attacks, somatization, exercise, hyperthyroidism and anemia.

00:03:30
Palpitations can also occur with valvular heart disease, increased or decreased stroke volume, and during arrhythmias.

00:03:40
Ask your patient about the frequency and duration of the palpitations, as well as the presence of any associated symptoms, such as a loss of consciousness, lightheadedness, chest pain, or pressure.

00:03:52
Or shortness of breath, nausea, or vomiting.

00:03:56
Occasionally, young healthy patients may have frequent PVCs that are benign in nature but warrant investigation to rule out serious causes.

00:04:04
[BLANK_AUDIO]

00:04:14
Syncope, or transient loss of consciousness, TLOC.

00:04:19
Syncope is a sudden loss of consciousness accompanied by an inability to maintain postural tone, followed by spontaneous recovery, which patients often describe as fainting.

00:04:30
This increases with age, especially in individuals over 70.

00:04:34
Physical therapists should assess the number and frequency of falls, the duration of syncope, the span of time between episodes, patient's caloric intake, fluid intake, hydration status.

00:04:46
Any evidence of substance abuse and the patient's vital signs.

00:04:51
A patient with multiple episodes occurring over a short period of time.

00:04:56
In other words several days or weeks, is more likely to be suffering from a serious underlying disorder such as intermittent highgrade, atrioventricular, block peroxisomal, ventricular tachycardia etc.

00:05:10
And these patients require aggressive evaluation.

00:05:13
However, it is unusual for multiple syncope episodes to occur in a single day.

00:05:18
Many episodes of apparent syncope each day, or episodes lasting many minutes in duration, may indicate that the patient is suffering from non syncope psychogenic disorders.

00:05:30
Are what's called psychogenic pseudosyncope, or psychogenic pseudoseizures.

00:05:37
In general, the longer the period of time over which episodes have occurred, for example, many years versus a recent onset.

00:05:44
And the younger the patient's age at onset, particularly when the patient is less than 35 the less likely it is that the cause of syncope is life threatening unless the individual has identifiable structural heart disease.

00:05:56
[BLANK_AUDIO]

00:06:02
Syncope, prognosis and level of seriousness, the term syncope is often misapplied to seizures or other issues which are not accompanied by a transient loss of consciousness.

00:06:15
Syncope is self terminating and it's the result of inadequate nutrient flow to the brain.

00:06:22
Establishing the likely cause of this can help establish prognosis.

00:06:26
Syncope during exercise or during exertion is serious.

00:06:30
Syncope following exercise or after exertion is less serious.

00:06:37
Neurocardiogenic syncope, also called vasovagal syncope, is a common cause of dizziness and fainting.

00:06:43
And it is the result of a sudden decrease in blood pressure and heart rate after prolonged standing or through stress or by dehydration.

00:06:53
It is a result of sympathetic sensitivity causing a reflexive response that suddenly causes bradycardia and venous dilation.

00:07:01
The result is hypotension and dizziness.

00:07:05
The timing of syncope in relation to exercise is very important, as syncope during a full flight exercise may be indicative of a serious condition.

00:07:15
While syncope immediately after exercise tends to be more innocent and reflects an origin.

00:07:22
Syncope that occurs during exertion suggests a potentially life threatening etiology.

00:07:27
And this should be taken very seriously.

00:07:30
On the other hand, syncope that occurs soon after the termination of exertion, for example during the cooling off, is more likely reflex in origin, similar to a vasovagal fainting.

00:07:42
[BLANK_AUDIO]

00:07:49
So, this chart is intended to help illustrate potential causes of syncope, and when you have time, please take a brief look through it.

00:07:57
[BLANK_AUDIO]

00:08:03
What I'd like you to take away from the chart is that there are neurally mediated causes of syncope.

00:08:09
There are causes of syncope that are related to orthostatic hypotension and there are cardiovascular causes of syncope.

00:08:18
[BLANK_AUDIO]

00:08:23
Determining whether pain is associated with cardiovascular pathology.

00:08:27
[BLANK_AUDIO]

00:08:30
So chest pain or tightness extending into the left upper extremity is typically associated with cardiovascular pathology.

00:08:37
Jaw, neck, tooth, right shoulder, epigastric and midthoracic pain be refered from cardiovascular pathology.

00:08:46
Pain in this locations accompanied by excessive sweating, especially in a patient with additional risk factor for cardiac disease should raise suspicion of cardiovascular origin.

00:08:58
Pain from coronary related ischemia is more often characterized as non

focal chest discomfort or pressure than pain.

00:09:07
The onset is generally gradual and is exacerbated by activity.

00:09:12
Discomfort that radiates particularly to either or both arms should increase suspicion for cardiovascular disease.

00:09:20
A personal or family history of cardiovascular disease, older age, diabetes, dyslipidemia, cigarette smoking, hypertension, or drug use all increase the likelihood.

00:09:33
Females are more likely to have associated dyspnea than males and patients who are older or have diabetes.

00:09:40
I'm more likely to present with dyspnea without chest pain.

00:09:43
[BLANK_AUDIO]

00:09:50
Certain medications may cause the patient to sweat excessively.

00:09:53
This chart is an example of some of those medications which include antidepressants, cholinergic agents, hormonal agents, hypoglycemics sympathomimetic agents and other agents including beta blockers.

00:10:06
[BLANK_AUDIO]

00:10:15
Red flags for chest pain and pressure include a sudden onset of chest pain and pressure, a severe crushing, chest pain and pressure is described by the patient.

00:10:25
Chest pain lasting more than 15 minutes.

00:10:28
Pain that worsens with exertion and physical activity.

00:10:31
Chest pain which is accompanied by shortness of breath, nausea, excessive sweating, or vomiting.

00:10:39
Chest pain accompanied by left arm, neck or radiating jaw pain also, changes in vital signs, such as tachycardia, bradycardia, or hypotension.

00:10:49
When communicating with the physician, include vitals, symptoms, duration, intensity.

00:10:55
Is this the initial episode?

00:10:57
Is the pain constant or is it intermittent?

00:11:01
The coronary arteries supply blood to the heart muscle and narrowing in one of the coronary arteries results in decreased blood supply.

00:11:10
And when the lesion becomes significant, myocardial ischemia and chest pain occur.

00:11:15
Any complaint of chest pain or other symptoms suggestive of ischemia should be thoroughly investigated.

00:11:22
Initially, determine whether the patient is having active cardiac symptoms during the evaluation, which would require emergent transport to the closest emergency department using EMS.

00:11:34
Symptoms associated with the highest relative risk of myocardial infarction include radiation to an upper extremity, particularly when there is radiation to both arms.

00:11:43
And pain associated with diaphoresis or with nausea and vomiting.

00:11:48
An important question is whether current pain is reminiscent of prior myocardial infarction.

00:11:54
Of note no one pain characteristic has sufficient positive or negative, predictive value to definitively diagnose versus fluid acute cardiac symptoms.

00:12:06

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9.6 Cough and Respiratory Symptoms

00:00:01
9.6, cough and respiratory symptoms

00:00:04
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00:00:08
The objectives for this lecture.

00:00:11
By the end, you should be able to describe strategies for following up on cough-related general health screening questions.

00:00:18
Identify potential danger signs associated with the history of cough.

00:00:23
Identify items included in the pulmonary systems checklist.

00:00:27
Describe strategies for following up on respiratory sounds.

00:00:31
Identify items included in the hematological systems checklist.

00:00:35
And describe important hematological signs and symptoms to be aware of, especially if checklist items are worrisome.

00:00:40
[BLANK_AUDIO]

00:00:46
So the presence of a cough may trigger concerns regarding pulmonary system or cardiovascular system pathology.

00:00:54
A cough at night could be associated with heart failure or calcium channel blockers.

00:00:59
You should inquire whether there's history of cigarette smoking, allergies, or even post-nasal drip associated with the cough.

00:01:06
[BLANK_AUDIO]

00:01:08

So the presentation of a cough should trigger concern about the pulmonary system, but also with disorders of the cardiovascular system.

00:01:16
[BLANK_AUDIO]

00:01:19
The cough may be associated with very serious disorders such as asthma, pneumonia, cancer, or even heart failure.

00:01:26
However, keep in mind that a cough is an extremely common and potentially nonspecific complaint.

00:01:33
So how do we determine how serious the cough is clinically?

00:01:36
[BLANK_AUDIO]

00:01:42
Follow-up questions you might ask a patient who presents with a cough include, how long have you had the cough?

00:01:48
What do you think the cause is?

00:01:50
Is your cough constant?

00:01:52
Is it related or does it change with your position or posture?

00:01:56
Is it a productive cough?

00:01:57
And so, what's the color of the sputum?

00:02:00
Is your cough painful?

00:02:02
You should also assess whether symptoms on the general health checklist are associated with the cough.

00:02:07
[BLANK_AUDIO]

00:02:09
A productive cough lasting three weeks or longer should raise concern.

00:02:15
Sputum that is yellow, red, rust, or green is likely associated with pathology.

00:02:20
A cough associated with heart failure may occur in a recumbent position.

00:02:25
Chest auscultation may be appropriate for the physical therapist, if serious underlying pathology is suspected.

00:02:32
The patient history should include a thorough analysis of the cough, including a determination of how long it has persisted.

00:02:40
It's essential to identify any associated symptoms including shortness of breath, wheezing, orthopnea, fever, chills, chest pain or discomfort, sputum production, post-nasal drainage, and hemoptysis.

00:02:55
The medical history should be comprehensive, with a particular focus on the potential for asthma, COPD, chronic or acute bronchitis, heart failure, GERD, or recent upper or lower respiratory infections.

00:03:12
The medication history will not only exclude the potential for ACE inhibitor induced cough, but will also identify other problems for which medications are taken.

00:03:21
The patient's prior self-treatment or prescribed treatment of cough should be explored, including the response and tolerance of the treatment.

00:03:29
The patient's family history should also be established.

00:03:32
[BLANK_AUDIO]

00:03:37
Potential danger signs associated with a cough include fever, night sweats, purulent sputum, dyspnea, and hemoptysis.

00:03:46

You should also inquire whether your patient has spoken with their physician.

00:03:51
Important danger signs that we will need further evaluation with the chest radiograph and possible laboratory testing and CT include the following.

00:04:00
Fevers, night sweats, or weight loss raise suspicion for chronic infection such as tuberculosis, lung abscess, or rheumatic disease.

00:04:09
Purulent sputum warrants evaluation for pulmonary and possibly sinus infection, followed by treatment of identified infections.

00:04:17
Hemoptysis can be an indicator of infection, such as lung abscess or tuberculosis, cancer, for example, lung, bronchus, or larynx cancer, or rheumatic diseases, heart failure, or foreign body inhalation.

00:04:32
Dyspnea can be a clue to airway obstruction or a lung parenchymal disease.

00:04:38
Other features such as waxing and waning versus progressively worsening symptoms, particular triggers, associated hoarseness, and focal abnormalities on examination can help focus the investigation.

00:04:50
Pulmonary function testing, including pre and post-bronchodilator testing, is important to characterize the potential problem causing both dyspnea and cough.

00:05:02
Immunosuppression can be a risk factor for infections such as tuberculosis, and it should prompt a diligent and rapid evaluation for infection.

00:05:10
[BLANK_AUDIO]

00:05:17
Peripheral edema is when fluid collects in the lower extremities in ambulatory patients.

00:05:23
In non-ambulatory patients, it tends to collect in the sacral area.

00:05:27
Non-pathologic causes include poor venous return.

00:05:31
Pathological causes include heart failure, kidney disease, tumors obstructing the venous return.

00:05:38
Lower extremity edema may be an early sign of heart failure.

00:05:41
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00:05:43
As I mentioned above, in ambulatory patients, fluid collects dependently in the lower extremities.

00:05:49
In non0ambulatory patients, it collects in the sacral area.

00:05:53
Non-pathological causes of edema include poor venous return in prolonged standing or sitting.

00:05:59
Pathologic causes of edema result from right or left heart failure, kidney disease, liver disease, or tumors that obstruct venous return.

00:06:09
One of the early signs of heart failure is pretibial and ankle edema.

00:06:14
Kidney failure causes fluid retention.

00:06:16
And hepatic disease may cause ascites, which contribute to peripheral edema.

00:06:20
[BLANK_AUDIO]

00:06:27
Peripheral edema may be associated with serious underlying disorders, such as venous insufficiency, congestive heart failure, DVT, and pulmonary hypertension.

00:06:36
[BLANK_AUDIO]

00:06:38

If the edema is unilateral, this raises concern for DVT, so you should assess whether there is a history of blood clotting disorders.

00:06:47
If the edema is bilateral, this is usually in older adults and usually chronic and related to chronic venous disease, heart failure, medications, or pulmonary hypertension.

00:06:59
Acute bilateral leg edema is rare and associated with medications, acute heart failure, nephrotic syndrome, malignancy-related bilateral DVT.

00:07:08
Finally, you should assess whether the edema is pitting or non-pitting.

00:07:13
It's essential to consider the diagnosis of DVT in patients with acute unilateral or asymmetric leg edema.

00:07:20
Peripheral edema can be pitting or non-pitting.

00:07:23
Pitting edema is more common and is defined by the presence of tissue depression after pressure is applied to the area for at least five seconds.

00:07:33
Pitting edema generally reflects the movement of the excess interstitial water in response to pressure.

00:07:39
Non-pitting edema suggests lymphatic obstruction or hypothyroidism.

00:07:43
[BLANK_AUDIO]

00:07:54
Moving on to the pulmonary system checklist, I'd like you to take a look at Box 9.6 in your textbook.

00:08:02
Note that wheezing is a high pitched noise related to partial airway obstruction, while stridor is a high pitched noise associated with trachea or larynx obstruction.

00:08:11
You should watch for additional signs of pulmonary distress.

00:08:14
[BLANK_AUDIO]

00:08:17
This pulmonary distress may be associated with asthma, bronchitis, COPD, or even malignancy.

00:08:24
Note the quote at the bottom, all that wheezes is not asthma, and all that wheezes is obstruction.

00:08:30
[BLANK_AUDIO]

00:08:38
Regarding respiratory sounds, some questions you may follow up with include asking your patients if they've noticed this noise before.

00:08:48
Ask them, do you know why the sound exists?

00:08:51
How long has it been present?

00:08:53
How often does it occur?

00:08:55
Are there any factors that seem to cause or worsen it?

00:08:59
According to UptoDate, there are at least 29 potential causes of wheezing in the upper airway, the central airway, and the lower airways.

00:09:08
Wheezing is an audible respiratory sound often associated with the sense of chest tightness and/or dyspnea.

00:09:15
Many of the conditions included in the preceding discussions of cough and dyspnea also cause wheezing and chest tightness.

00:09:22
For this reason, the history and physical assessment of this complaint are the same as for the other respiratory complaints and should be thorough.

00:09:31

Questions relevant to wheezing or stridor include the above.

00:09:34
[BLANK_AUDIO]

00:09:41
The hematologic system checklist is in Box 9.7 of your textbook.

00:09:46
Blood disorders include erythrocyte, leukocyte, platelet conditions, and bleeding disorders.

00:09:52
These can be associated with potentially severe underlying disease.

00:09:56
The symptoms and signs here may alert the therapist to communicate with the patient's MD.

00:10:02
Abnormal bleeding, in addition to cuts and scrapes that demonstrate prolonged bleeding, include excessive menstruation, vomiting blood, and melena, along with gingival bleeding and hemarthrosis or blood in the joints.

00:10:17
Be aware of normal clinical laboratory values for complete blood count and platelets, as well as rehabilitation guidelines and potential symptoms associated with high and low values.

00:10:27
[BLANK_AUDIO]

00:10:31
Hematological disorders, signs and symptoms.

00:10:34
So first, you should ascertain whether there's a history of a hematologic disorder.

00:10:40
Is there easy bruising, fatigue, shortness of breath, fever, or frequent infections, presence of liver disease, and/or alcohol abuse?

00:10:49
Risk factors for hepatitis, presents of leukemia, thrombocytopenia, coagulopathies may be associated with bruising, fever, and petechiae.

00:10:58
A rapid heart rate or murmur, nail cyanosis may be present, capillary

refill may be altered.

00:11:05
Hematologic disorders are likely to cause increased bleeding, and those disorders include thrombocytopenia, leukemia, aplastic anemia, and hereditary coagulopathies.

00:11:17
Multiple hematologic disorders can be seen with liver disease, including anemia, thrombocytopenia, leukopenia, leukocytosis, and impaired synthesis of clotting factors.

00:11:27
[BLANK_AUDIO]

9.7 Upper Gastrointestinal Symptoms

00:00:01
Lecture 9.7, the upper gastrointestinal symptoms.

00:00:06
[BLANK_AUDIO]

00:00:09
So by the end of this lecture, you should be able to,

00:00:13
[BLANK_AUDIO]

00:00:15
Describe strategies for follow-up questions with patients who have difficulty swallowing.

00:00:20
Describe strategies for follow-up questions with patients who suffer from dyspepsia.

00:00:26
Identify additional physical examination strategies for a patient who presents with a worrisome history of dyspepsia.

00:00:34
Identify important questions to ask your patient regarding upper GI bowel function.

00:00:39
And define melena and acholic stool and pathologies that may be associated with these findings.

00:00:44
[BLANK_AUDIO]

00:00:49
So I'd like you to take a look at Box 9.8 in your textbook.

00:00:53
Dysphasia can sometimes be associated with nausea and vomiting.

00:00:57
Dysphasia is difficulty swallowing and represents a loss of muscle control or an obstruction.

00:01:05
Causes of muscle incoordination can include underlying disorders such as, myasthenia gravis, multiple sclerosis, muscular dystrophy,

Parkinson's, dermatomyositis or poliomyelitis.

00:01:18
Mechanical obstructions can include things like underlying causes such as cancer, peptic stricture secondary to gastroesophageal reflux disease or esophageal rings.

00:01:31
Mechanical disorders are usually limited to solid food.

00:01:34
[BLANK_AUDIO]

00:01:35
The history is particularly important in these patients because physical examination is really of little value when diagnosing dysphagia.

00:01:44
Ask your patient whether they have difficulty swallowing only with liquids or does it also occur with solids, discern whether it is constant or intermittent.

00:01:54
Ask your patient about a history of cancer, neuromuscular or autoimmune diseases or GERD.

00:02:00
If the patient is elderly, inquire whether there have been frequent bouts of pneumonia or a chronic cough, which might alert you to aspiration as a cause.

00:02:09
Ask your patient about any medications that they're currently on.

00:02:12
The bisphosphonates a drug class used for treating osteoporosis can cause esophagitis especially if not taken with a full glass of water.

00:02:23
Ask about habits such as smoking and alcohol intake because cancers of the head and neck are more common in individuals with a history of tobacco and/or alcohol use or abuse.

00:02:33
[BLANK_AUDIO]

00:02:40
In your textbook, please take a look at Table 9.3.

00:02:44
So where does the patient sense the difficulty swallowing is physically located?

00:02:49
Is that difficulty associated with solids, liquids, or both?

00:02:52
Is the difficulty swallowing associated with discomfort?

00:02:56
Dysphagia is characterized as an esophageal transport disorder.

00:03:00
And it's caused by lesions of the pharynx and esophagus, or by neuromuscular disorders that cause functional limitations.

00:03:07
It's important to differentiate between pre-esophageal dysphagia, which occurs mostly in patients with neuromuscular disorders, and esophageal disorders, which can include obstructive or motor disorders.

00:03:19
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00:03:25
Dyspepsia, common symptoms of dyspepsia are indigestion and heartburn.

00:03:30
The causes can be organic, but they may also be difficult to ascertain.

00:03:35
You might ask your patient, how long have you had these symptoms?

00:03:38
Do you know what worsens or improves them?

00:03:40
Are they constant?

00:03:42
How are you currently treating your symptoms?

00:03:44
Are there other symptoms associated with it?

00:03:47
Epigastric pain can represent the heartburn or dyspepsia often

associated with gastro–esophageal reflux disease as well as several other diseases, including malignancies.

00:03:58
The epigastric region is a very common site of discomfort, stemming from many digestive structures.

00:04:04
Heartburn, often GERD, is a very common complaint.

00:04:08
Patients may use alternative terms to describe the sensation of heartburn, including indigestion or sour stomach.

00:04:15
Dyspepsia covers a variety of complaints that include heartburn, fullness, bloating, and upper abdominal pain.

00:04:22
Because pain in this region provides little specificity on its own, the history is crucial in narrowing down the differential diagnosis for someone with dyspepsia.

00:04:30
[BLANK_AUDIO]

00:04:36
Dyspepsia additional examination.

00:04:38
Have there been any changes in your patient's vital signs?

00:04:42
Associated weight loss or abdominal mass may suggest malignancy.

00:04:46
Abnormalities in skin tone may be associated with liver disease, cholecystitis or hypoxia related to cardiac or respiratory disease.

00:04:55
Examination of abdominal sounds for an aortic bruit may be useful.

00:05:00
Also, the presence of abdominal pain with palpation may be important.

00:05:04
The patient should point to the exact location of their pain.

00:05:08
Important considerations include vomiting, regurgitation, diaphoresis,

dysphagia, blood in the stool or hematemesis.

00:05:16
Shortness of breath fatigue, weight loss and radiation to other sites, including intro and extra abdominal sites.

00:05:23
Ask your patient whether they're taking any new medications.

00:05:27
Gastric ulcer symptoms may be worsened by eating, whereas eating may relieve symptoms related to other conditions.

00:05:34
For example, duodenal ulcer symptoms may be relieved by food.

00:05:38
[BLANK_AUDIO]

00:05:45
Upper GI bowel function.

00:05:47
Melena are black, tarry stools which represent bleeding in the upper gastrointestinal system.

00:05:54
Ask your patient whether there's a prior history of melena.

00:05:57
If reported, follow up questions related to the duration, does the patient feel lightheaded?

00:06:03
Other associated symptoms, nausea, vomiting, diarrhea, fatigue, abdominal or back pain.

00:06:10
Check for abdominal tenderness and look at the vital signs, establish the history of bowel movements, are there any indications of bleeding, including gums, bruising, etc?

00:06:20
Black stools may also be associated, however, with Pepto-Bismol, black licorice, and some brands of chocolate cookies.

00:06:28
When a patient presents with GI bleeding, the first step must be to determine his or her hemodynamic stability.

00:06:35
Stability is assessed to a large extent by consideration of the patient's vital signs and their general appearance.

00:06:43
Patients should be asked about prior episodes of upper GI bleeding, since up to 60% of patients with a history of upper GI bleeding are bleeding from the same lesion.

00:06:53
The timing and progression and description of the blood should also be noted.

00:06:58
When melena is present, the blood is likely to have been present for over 14 hours.

00:07:03
Therefore, the site of bleeding is most likely distant from the rectum, so it's most likely in the upper GI.

00:07:09
The presence of abdominal pain, especially if severe and associated with rebound tenderness or involuntary guarding, raises concern for perforation.

00:07:17
[BLANK_AUDIO]

00:07:24
Upper GI bowel function.

00:07:26
Acholic stools are light gray or pale stools, and they may be associated with jaundice.

00:07:32
They're also seen in viral hepatitis and pancreatic or duodenal cancer-related bile duct obstruction.

00:07:39
If reported, ask about the duration, and any atypical urine color.

00:07:43
Ask your patient about fever, especially chills, or right upper quadrant pain and/or history of biliary surgery.

00:07:51
Any presence of anorexia malaise, or myalgias may suggest a viral hepatitis.

00:07:57
Symptoms associated with jaundice may include pruritus, malaise, fever, chills, nausea, anorexia, change in the color of urine or feces, and abdominal pain.

00:08:08
The medical history must address previous hepatic or biliary diseases, malignancy, hemolytic disorders, and surgery, as well as other potential contributing disorders, including congestive heart failure.

00:08:21
Make sure to obtain a family history of hemolytic, biliary, and hepatic disorders.

00:08:27
Obtain a thorough medication history, including over-the-counter and herbal agents.

00:08:31
Determine the use of alcohol and recreational drugs, particularly IV drug use, and social risk factors for hepatitis, including sexual practices.

00:08:40
[BLANK_AUDIO]

9.8 Lower Gastrointestinal Symptoms

00:00:01
Lecture 9.8 covers lower gastrointestinal symptoms.

00:00:09
By the end of the lecture, you should be able to identify the important components of lower GI screening to be able to define hematochezia and describe follow up questions to ask a patient Who describes symptoms consistent with hematochezia.

00:00:24
Describe follow-up questions related to constipation and describe follow-up questions related to diarrhea.

00:00:29
[BLANK_AUDIO]

00:00:36
Lower gastrointestinal screening for symptoms.

00:00:39
Take a look at Box 9.8 in your textbook.

00:00:42
The screening of the lower gastrointestinal tract is based on questions about bowel function including the color of stools the shape and the caliber of stools constipation diarrhea difficulty initiating a bowel movement and incontinence.

00:00:56
[BLANK_AUDIO]

00:01:01
Hematochezia is the passage of bright red blood and stools, and if that's present, then you should ask your patient, how long has this been occurring?

00:01:10
Is there any history of GI bleeding?

00:01:13
Are there other symptoms associated with this, such as difficulty initiating bowel movements, or do they feel lightheaded?

00:01:20
Is blood only in the stool or is there blood in the absence of stool?

00:01:25
Make sure and check your patient's vital signs.

00:01:27
Also inquire about medication use, including NSAIDs, anticoagulants and antiplatelet agents.

00:01:34
Hematochezia or the passage of bright red blood in the stools usually originates in the left side of the colon, or the distal colon.

00:01:41
Evaluation of a patient presenting with minimal bright red blood per rectum must be guided by the risk of underlying serious pathology.

00:01:51
Causes may be grouped into anatomic, such as diverticulosis vascular which is angio, dysplasia, and inflammatory, such as infectious disease and neoplastic causes.

00:02:04
In addition, acute lower GI bleeding can occur after therapeutic interventions such as polypectomy, benign ideologies are common and appear to account for 90% or more of all episodes of hematochezia.

00:02:18
[BLANK_AUDIO]

00:02:26
Continuing with hematochezia, systemic symptoms such as night sweats, fever, or weight loss suggest malignancy or chronic infection or inflammation.

00:02:37
Diarrhea preceding or accompanying the passage of blood suggests colitis.

00:02:42
Nonspecific abdominal pain indicates a process that may include but is not limited to the rectum.

00:02:48
Lastly, change in the frequency or caliber of stools is suggestive of colonic malignancy.

00:02:54
The presence of any of these symptoms suggests that further evaluation should be performed.

00:02:58
[BLANK_AUDIO]

00:03:04
Please take some time and look at table 9.4 in your textbook.

00:03:07
If you suspect your patient is suffering from constipation, some follow up questions might be how long has this been going on, or asking your patient when was your last bowel movements?

00:03:17
We're asking them, do you experience constipation alternating with diarrhea?

00:03:22
If this is the case, you may consider possible cancer or diverticulitis as a cause.

00:03:28
You might ask your patient, are there any other symptoms associated with this, such as malaise, fatigue, abdominal fullness, fever, agitation, or altered mental status?

00:03:39
Make sure to check vital signs.

00:03:41
Also take a good history of medications, especially whether your patient is taking any opiates.

00:03:47
Constipation is at some point experienced by almost everyone, but for some patients, it can represent serious underlying pathology.

00:03:55
The associated symptoms described in the last question, represent potential manifestations of fecal impaction and should prompt immediate communication with the patient's physician.

00:04:04
[BLANK_AUDIO]

00:04:16
If during your patient history you suspect that your patient may be suffering from diarrhea you might ask them, hw many episodes per day?

00:04:24
How long have you been experiencing this?

00:04:26
Was the onset gradual or sudden?

00:04:28
Do you have a period when it alternates with constipation?

00:04:32
Is it worse at certain times of the day?

00:04:35
Do family members have similar symptoms?

00:04:38
Any recent meals or travel that may be associated with these symptoms?

00:04:42
Are there any other symptoms associated with this such as fever, chills, nausea, vomiting, confusion, abdominal pain or bloating?

00:04:50
[BLANK_AUDIO]

00:04:52
The causes of diarrhea are numerous and include bacterial origin, viral, organic origin and functional.

00:04:59
[BLANK_AUDIO]

00:05:01
Most cases are self-limiting and resolve within days without medical intervention.

00:05:07
However, when a high fever, intractable vomiting, or severe dehydration is present, prompt attention is necessary and hospitalization frequently is required, especially in children or geriatric patients.

00:05:20
Dehydration and electrolyte depletion are concerns.

00:05:23
Also, be aware that stress or anxiety could be a factor and psychosocial issues may be investigated.

00:05:29
[BLANK_AUDIO]

00:05:35
Constipation and diarrhea follow up.

00:05:38

Make sure to examine vital signs, particularly determining the presence of fever, which might indicate infection, and tachycardia or orthostatic hypotension, which might indicate dehydration.

00:05:51
Other signs of dehydration include dry mucous membranes, lightheadedness, syncope, lethargy and oliguria.

00:06:00
If there is accompanying electrolyte imbalance, cardiac arrhythmias, muscle weakness, tetany, or vascular collapse may occur, particularly in young children, the elderly, or patients who are already debilitated.

00:06:15
Listen for hypoactive or hyperactive bowel sounds, which could indicate early obstruction.

00:06:20
Also palpate for abdominal tenderness.

00:06:23
This could indicate infection or inflammation

00:06:26
[BLANK_AUDIO]

9.9 Genitourinary Symptoms

00:00:01
Lecture 9.9, Genitourinary Symptoms.

00:00:05
[BLANK_AUDIO]

00:00:08
So by the end of this lecture, you should be able to describe how the color of urine can be indicative of pathology.

00:00:14
You should be able to define hematuria, dysuria, nocturia, and polyuria.

00:00:21
Identify follow up questions given a situation in which you suspect your patient may be suffering from hematuria, dysuria, nocturia, or polyuria.

00:00:30
You should be able to identify genitourinary system red flag signs and identify red flag signs associated with reproductive function

00:00:37
[BLANK_AUDIO]

00:00:44
Please refer to box 9.9 in your textbook, Genitourinary System Checklist.

00:00:51
Color of urine may be an indicator of pathology.

00:00:56
A dark color may be associated with hepatic or biliary obstruction or acute rhabdomyolysis.

00:01:03
Hematuria, blood in the urine can be a sign of many different diseases in the urinary tract.

00:01:09
Urine may also be read from ingesting vegetable dyes, beets, or certain medications like Pyridium.

00:01:17
Be aware that over the lifespan, storage, function, and bladder outlet obstruction for both genders varies.

00:01:24
Bright red urine, may indicate urological or anatomic cause.

00:01:28
While a tea colored or brown urine may be due to old clots, glomerulonephritis, or other medical causes.

00:01:34
[BLANK_AUDIO]

00:01:40
Hematuria, follow-up questions you might ask your patient include, how long have you had red urine?

00:01:47
Do you have a history of bleeding problems?

00:01:49
Have you noticed your urine changing colors while voiding from clear to red or vice-versa?

00:01:54
Have you recently had an upper respiratory infection?

00:01:57
Inquire about current medications as well as associated symptoms such as fever, weight loss, fatigue, flank, or abdominal pain.

00:02:05
[BLANK_AUDIO]

00:02:13
Red urine noted one to two weeks after an upper respiratory tract infection may be associated with acute glomerulonephritis.

00:02:21
[BLANK_AUDIO]

00:02:25
Disuria, nocturia, and polyuria.

00:02:29
Dysuria is burning pain or discomfort during urination.

00:02:33
Nocturia is waking at night multiple times to urinate.

00:02:37
Polyuria is increased amounts of urine.

00:02:41
Complaints of dysuria, burning, pain, or discomfort on urination are more common in women than in men, and this is largely a result of the shorter urethral length in women.

00:02:53
Infection is the most common cause of dysuria and its presentation depends on which structure of the genitourinary tract is affected.

00:03:03
The infection can be secondary to anatomical abnormality or abnormality of function, including postmenopausal status or prostatic hypertrophy.

00:03:14
The patient may have undergone recent genitourinary instrumentation or catheter placement, leading to a mechanical cause for the dysuria.

00:03:23
Dysuria can also be an indicator of other systemic conditions such as diabetes, renal calculi, genitourinary neoplasms, or depression.

00:03:33
Nocturia is a source of significant bother for some patients, especially if there are two or more episodes per night.

00:03:40
It is one of the most distressing symptoms in older men with benign prostatic hyperplasia.

00:03:45
And nocturia is strongly associated with poor quality of life ratings.

00:03:50
Nocturia is associated with increased rates of depression, work absenteeism, and lower self rate of physical and mental health.

00:03:58
In older patients, it's associated with higher rates of accidental falls and subsequent fractures.

00:04:06
Polyuria is defined as greater than three liters per day of urine output, often glucose induced in patients with uncontrolled diabetes mellitus.

00:04:16
Other causes, such as polydipsia, result in dilute or clear urine and are the result of increased water intake.

00:04:23
[BLANK_AUDIO]

00:04:30
Follow up questions you may ask a patient you suspect has dysuria, nocturia, or polyuria.

00:04:38
Ask about the duration, was the onset rapid or delayed?

00:04:42
Ask the patient about whether they've been drinking more fluids than usual.

00:04:46
Ask them about their medications and whether they're taking any diuretics.

00:04:50
Ask them about whether, despite an urge to urinate, they cannot start urination.

00:04:55
And after the flow has stopped, do they experience the sensation of still needing to urinate?

00:05:01
Do they suffer from associated symptoms such as headaches, visual problems, diabetes related problems, fever, nausea or weight loss?

00:05:11
Symptoms of reduced force or caliber of urine flow and difficulty in starting the urine stream are common symptoms associated with obstructive disorders, including benign prostatic hyperplasia, BPH.

00:05:23
For patients already diagnosed with BPH, the physician will be aware of the urinary difficulties, but the PT should forward any reports that the urinary flow problems may have worsened.

00:05:34
[BLANK_AUDIO]

00:05:35
The term benign may be misleading because BPH can result in complications of hydroureter and renal failure.

00:05:42
[BLANK_AUDIO]

00:05:44
True urinary retention is associated with serious conditions such as cauda equina syndrome.

00:05:49
[BLANK_AUDIO]

00:05:55
Red flags, refer a patient with hematuria urgently to a urologist.

00:06:02
Abrupt onset or worsening of testicular pain, regardless of age, warrants referral.

00:06:07
Anuria or oliguria require aggressive evaluation or admission for management, so refer out.

00:06:14
Acute urinary retention must be referred to the nearest emergency department.

00:06:18
Large kidney masses accompanied by gross hematuria, flank pain, and a palpable mass should be referred emergently.

00:06:26
Pain associated with any genitourinary structure that wakes the patient at night or prevents sleep should warrant referral.

00:06:32
A toxic-appearing patient with poor urine output may warrant referral.

00:06:38
Make sure to communicate the pertinent history, vitals, and pertinent physical findings.

00:06:42
[BLANK_AUDIO]

00:06:53
Urinary incontinence, urinary incontinence is the involuntary leakage of urine, it affects 20 million adults.

00:07:03
Patients may be reluctant to discuss.

00:07:07
It's more common in females, particularly in pregnancy, obesity, and

with age, also with decreased estrogen.

00:07:14
In males, the rates increase after bladder surgery, with age, and during prostate enlargement.

00:07:20
[BLANK_AUDIO]

00:07:24
It's estimated that nearly 50% of adult women experience urinary incontinence, yet only 25 to 61% of symptomatic community dwelling women actually seek care.

00:07:36
The prevalence of urinary incontinence increases as age increases for both genders.

00:07:41
Approximately 50% of elderly people in extended care are incontinent of urine.

00:07:47
[BLANK_AUDIO]

00:07:53
If you suspect a patient may be suffering from urinary incontinence, follow-up questions include, are there any specific activities associated with your incontinence?

00:08:02
When do you notice the incontinence occurring?

00:08:05
Also inquire about medical and surgical history.

00:08:09
Ask about activities that seem to trigger urine loss and any efforts the patient has taken to avoid or adapt to the incontinence.

00:08:17
[BLANK_AUDIO]

00:08:22
I included this table of selected causes of urinary incontinence to give you an idea that there can be a number of different causes.

00:08:31
There can be many different factors associated with the onset of urinary incontinence.

00:08:36
So to summarize, obtain a thorough genitourinary history, including a detailed description of the type of incontinence experience.

00:08:44
Ask about activities that seem to trigger urine loss and any efforts the patient has taken to avoid or adapt to the incontinence.

00:08:51
[BLANK_AUDIO]

00:09:01
Reproductive function, presence of a discharge or sexual dysfunction may be indicative of pathology in males or females.

00:09:09
[BLANK_AUDIO]

00:09:11
Is there presence of a urinary tract infection or a sexually transmitted infection?

00:09:16
You might ask the patient, what is the frequency of the discharge?

00:09:19
Is it a continuous flow, spotting, or sporadic episodes?

00:09:24
What's the color of the discharge?

00:09:26
Is the discharge accompanied by an odor?

00:09:29
Are there associated symptoms such as pruritus, itching, local pain or inflammation, fever, or nausea?

00:09:35
[BLANK_AUDIO]

00:09:38
Areas of overlap among women and men are common.

00:09:43
[BLANK_AUDIO]

00:09:45
Be aware that the discharge may be a sign of infection.

00:09:48
[BLANK_AUDIO]

00:09:54
The term dyspareunia refers to pain associated with sexual intercourse, which can affect men as well as women and cause significant psychologic distress.

00:10:03
Some patients presenting with mechanical low back, sacroiliac, and hip joint conditions report dyspareunia, pain during or after sexual intercourse.

00:10:13
Mechanical pain is usually associated with certain positions.

00:10:17
If there's erectile dysfunction, is it associated with neurological pathology, spinal cord pathology, post-surgical complication, diabetes mellitus, or medications?

00:10:28
Pain of mechanical origin is typically associated with non-specific intercourse positions, whereas pain associated with pelvic origin likely will occur regardless of positions.

00:10:40
[BLANK_AUDIO]

00:10:42
If this is the case, consider referral to a physical therapist who specializes in pelvic floor dysfunction.

00:10:49
Risk factors for dyspareunia include pelvic floor muscle hypertonus, pelvic inflammatory disease, depression, anxiety, history of sexual abuse, period or postmenopausal status, and age less than 50.

00:11:03
Male dyspareunia is defined as recurrent or persistent genital or pelvic pain with sexual activity or sexual dysfunction that is present for three months or longer.

00:11:14
Genitourinary infection is suggested by dysuria, urethral discharge, and testicular swelling and tenderness.

00:11:20
[BLANK_AUDIO]

00:11:29
Red flags for male reproductive function.

00:11:33
Sudden onset of acute testicular pain.

00:11:36
Cellulitic or necrotic changes to the skin of the scrotum, penis, or perineal region.

00:11:42
An erection lasting more than 60 minutes after cessation of sexual activity, without a decrease in turbidity.

00:11:48
Inability to urinate.

00:11:50
A new or painful mass, or previously identified mass that is newly painful in the scrotum.

00:11:55
If any of these are present, referral is warranted.

00:11:59
Make sure to communicate the pertinent history, vitals, and pertinent physical findings.

00:12:05
The evaluation should proceed to a history of any condition that would affect the penis, testes, or hormones, including hypothyroidism or pituitary malfunction.

00:12:15
Any history of genitourinary surgeries, previous treatment for testicular or genitourinary malignancies, and a history of vasectomy.

00:12:23
[BLANK_AUDIO]

00:12:32
Menstrual reproductive function.

00:12:34
The goal is to identify any change from the usual pattern, anything that's grossly abnormal.

00:12:42
The menstrual history includes any episodes of a amenorrhea, the

absence of menstrual bleeding.

00:12:48
Menorrhagia, which is excessive bleeding at the time of the menstrual cycle.

00:12:52
Metrorrhagia, bleeding and irregular non-cyclic intervals.

00:12:56
And dysmenorrhea, just pain or cramping with menstruation, as well as post-menopausal bleeding.

00:13:04
Dysmenorrhea can be a primary process or a secondary process related to other pelvic pathology.

00:13:10
[BLANK_AUDIO]

00:13:17
Red flags associated with female reproductive function.

00:13:21
Significant unilateral adnexal pain in an early pregnant female.

00:13:26
Frank uterine bleeding in a pregnant female.

00:13:29
Frank uterine bleeding in a postpartum or post-abortion patient for more than seven days.

00:13:34
Fever or significant abdominal pain in a postpartum or post-abortion patient.

00:13:39
Free fluid in the peritoneal cavity, or ascites.

00:13:43
Uterine bleeding in a postmenopausal patient.

00:13:46
A uterus or ovaries that are fixed, hard or nodular on palpation.

00:13:52
All of these things warrant referral.

00:13:55

Communicate to the physician the pertinent history, the vitals, and pertinent physical findings.

00:14:02
The gynecological history is complex and complaints should not be treated lightly.

00:14:07
Gynecological cancers may be present with vague, non-specific complaints and an index of suspicion is necessary for early diagnosis and treatment.

00:14:17
The last menstrual period is one of the most important questions to ask, particularly when prescribing medications, because many are contraindicated in pregnancy.

00:14:27
Be aware of normal clinical laboratory values for complete blood count and platelets as well as rehabilitation guidelines and potential symptoms associated with low and high values.

00:14:36
[BLANK_AUDIO]

9.10 Other Systems

00:00:01
Review of symptoms from other systems nervous, endocrine and integumentary.

00:00:07
This is Lecture 9.10.

00:00:10
By the end of this lecture, you should be able to describe components of the nervous endocrine and integumentary systems review checklists.

00:00:19
You should be able to identify red flags for the integumentary system that may warrant referral.

00:00:26
We should also be able to describe common symptoms of psychological disorders from the psychological systems review checklist.

00:00:33
Finally, you should be able to identify symptoms that raise suspicion of underlying disorder from the musculoskeletal systems review.

00:00:39
And describe how to use the review of systems checklist, including based on medical history, and incorporating into follow up visits.

00:00:46
[BLANK_AUDIO]

00:00:53
Please take time to review box 9.1 in your textbook.

00:00:57
Use the entire body gram and note the location of any symptoms.

00:01:00
Also investigate the onset of symptoms.

00:01:04
Starting with an initial neurological screen consisting of questions during the patient interview, continue with the upper and lower quarter screens.

00:01:13
From box 9.1, numbness, tingling, weakness, tremors, seizure, vision changes, sexual difficulties, hearing problems, difficulty swallowing, urinary incontinence, vomiting without nausea and dizziness should all

be assessed.

00:01:27
[BLANK_AUDIO]

00:01:33
The endocrine systems checklist, please refer to box 9.11 in your textbook.

00:01:38
Note that endocrine disorders may present with a variety of symptoms.

00:01:42
Be aware of atypical symptom patterns, insidious onset, random appearance of symptoms, etc.

00:01:50
Most of these symptoms would be picked up during the patient history.

00:01:54
An atypical symptom pattern, for example, insidious onset, symptoms that come and go for no apparent mechanical reason, no consistent time of day, those random symptoms may raise the suspicion that the endocrine system is involved.

00:02:07
[BLANK_AUDIO]

00:02:15
The integumentary systems checklist, please refer to box 9.12 in your textbook.

00:02:23
Patient history questions may include information about skin, hair, nails, any new or unexplained or unusual changes in those areas.

00:02:34
Try and diagram wounds, abrasions, and bruises as you ask the patient about their symptoms.

00:02:39
During the physical examination, follow up using the body the body diagram.

00:02:45
Even though many skin disorders are self limiting, almost any skin condition can be extremely distressing for an individual.

00:02:52
Not only is a large portion of the skin clearly visible so that all

can see any abnormality, but the skin is also an extremely sensitive organ and its disorders invoke a wide range of symptoms.

00:03:04
However, in addition to minor self-limiting conditions, the skin serves as a barometer for overall health because it often exhibits changes occurring in response to serious underlying systemic problems.

00:03:16
[BLANK_AUDIO]

00:03:18
Follow-up questions for the integumentary system include the onset and progression of skin changes.

00:03:28
What exacerbates or relieves the problem, if anything?

00:03:31
How has it changed over time?

00:03:33
Are there any associated symptoms?

00:03:36
The onset and progression of the skin change should be noted.

00:03:40
Anything the patient believes may trigger, exacerbate, or relieve the problem should be noted.

00:03:45
Inquire about how it may have changed since it was first noticed and all associated symptoms, such as itching, fatigue, and so on.

00:03:53
[BLANK_AUDIO].

00:03:57
Additional integumentary follow-up questions regarding skin complaints.

00:04:05
Inquire about the presence of dryness or itchiness.

00:04:09
Are there any new sores, rashes or lumps, any new odor or changes in perspiration?

00:04:15

Any changes in warts, moles or lesions that bleed and do not heal?

00:04:19
Any change in skin color or texture.

00:04:22
Note that there are many medications which can affect the skin.

00:04:25
When a patient has a skin complaint, it's important to include a wide range of other integumentary symptoms in the review of symptoms.

00:04:33
Sorry, in the review of systems.

00:04:35
For instance, ask the patient about the following, dryness, pruritus, sores, rashes, lumps, unusual odor or perspiration, changes in warts or moles.

00:04:45
Lesions that bleed and don't heal, or areas of chronic irritation.

00:04:48
Establish whether the patient has noticed any changes in the skin's coloration or texture.

00:04:53
[BLANK_AUDIO]

00:05:02
Red flags associated with the integumentary system.

00:05:05
So if you notice integumentary systems that seem worrisome, right?

00:05:13
Such as presence of new sores, rashes, or lumps, for example, and those are accompanied by fever or ill appearance, extreme age, young or old, purpura or petechia, generalized or musculoskeletal pain.

00:05:30
Immunocompromised patients, lymphadenopathy commonly offending drugs or non healing chronic lesions, chronic irregular and evolving lesions greater than six millimetres or oral lesions.

00:05:41
You should communicate that along with the pertinent history, vitals and pertinent physical findings with the referring physician.

00:05:48
[BLANK_AUDIO]

00:05:57
Please review box 9.1 in your textbook, the psychological system.

00:06:01
So there's an incredibly extensive list of disorders.

00:06:04
Common symptoms of psychological disorders include fatigue, unexplained weight change, onset of confusion, difficulty concentrating and sleep disturbances.

00:06:13
The range of mental disorders is so extensive that providing screening protocols for this entire category of illness is really beyond the scope of your textbook and beyond the scope of this class.

00:06:26
Use the general health checklist along with other components from Box 9.1 to help screen.

00:06:30
[BLANK_AUDIO]

00:06:32
Fatigue, unexplained weight change, a change mentation or an onset of confusion or difficulty concentrating and sleep disturbance are symptoms associated with many psychological disorders.

00:06:42
[BLANK_AUDIO]

00:06:51
The musculoskeletal symptoms.

00:06:55
Make sure and inquire about the onset of symptoms.

00:06:59
Do the symptoms change over the course of the day?

00:07:01
Do they vary by activity, posture, or other event?

00:07:05
Are the symptoms worse at night?

00:07:08

Is there a correlation between your physical examination and the patient's symptoms or the patient's complaint suggested a systemic disease such as weight loss, fever, chills, fatigue, confusion.

00:07:21
Determining whether a symptoms story from the patient makes sense according to our understanding of basic and clinical sciences.

00:07:27
Along with existing risk factors for cancers, infection, fractures, and inflammatory disorders is the basis for deciding whether to communicate with the physician.

00:07:38
At this gross overview level, information that raises suspicion of a serious underlying disorder should lead you to further more focused investigation.

00:07:47
[BLANK_AUDIO]

00:07:57
Refer to box 9.13 in your textbook, checklist used by symptom, location or pain pattern.

00:08:03
Not all checklists are required for every patient.

00:08:06
Recognizing a typical patterns of symptoms is important when a patient presents with pain that is not predictable.

00:08:12
[BLANK_AUDIO]

00:08:16
Certain body systems may not present with a predictable pain location, but rather present with an atypical pattern of symptoms that move from one body region to another.

00:08:26
Symptoms may be inconsistent in their intensity, increasing and decreasing regardless of time of day, posture and physical activity.

00:08:33
[BLANK_AUDIO]

00:08:37
The review of systems checklist.

00:08:40
The use is based on medical history, the medical history will guide the checklist selection.

00:08:45
A patient with a history of cardiovascular disease may be screened with items from the cardiovascular checklist to gather useful information pertinent to this patient.

00:08:54
This may also provide a baseline which you may use to monitor progression of the disease.

00:09:00
For example, if the patient reports heart problems, one of the follow up questions to ask is what symptoms do you have with your heart problem?

00:09:08
Knowing that the patient has a history of cardiovascular disease, should guide you to ask additional questions from the cardiovascular checklist.

00:09:16
[BLANK_AUDIO]

00:09:20
It's important to pull out the checklist and use it at follow-up visits.

00:09:24
Not the entire thing and not every visit.

00:09:27
Just use certain portions to assess changes in the patient's status.

00:09:31
New complaints may warrant using different portions of the checklist.

00:09:35
It's not necessary to repeat the entire review of systems at every single visit, but at times, asking questions again at a follow-up visit is certainly appropriate.

00:09:45
[BLANK_AUDIO].

00:09:51
So to summarize, I know this is an extensive amount of information.

00:09:56
But you should recognize underlying disorders which may require a referral.

00:10:00
The disorder you recognize and refer out may be different than the patient's chief complaint.

00:10:06
You should try and minimize false alarms, but if you make a mistake, make it on the side of safety.

00:10:13
Make sure and remember follow-up questions about symptoms.

00:10:17
Is the patient's physician aware of the concerning symptoms?

00:10:20
Is the patient providing an accurate history?

00:10:23
Asking specific follow up questions about the patient's symptoms, learning whether the patient's physician is aware of the symptoms, and if the symptoms have worsened.

00:10:32
And finally, judging the patient's ability to give an accurate history does this complaint represents something new, different or unusual?

00:10:40
All contribute the ability to distinguish a red flag.

00:10:43
[BLANK_AUDIO]

00:10:52
In closing, musculoskeletal problems are common.

00:10:54
It is easy to become centered on the area where the pain is focused.

00:10:58
However, there may be underlying urgent problems requiring immediate recognition and treatment.

00:11:04
Appropriate use of the review of systems may alert you to underlying serious pathology.

00:11:10
Patients who have musculoskeletal problems usually present with pain, deformity or weakness.

00:11:16
Joint pain in general is the most common problem, and backache specifically is the most common disorder for which patients seek health care.

00:11:23
The examination is often centered on the joints where the pain is focused.

00:11:27
But frequently, muscles and nerves are also a focal point of the examination.

00:11:33
Conditions associated with joint pain can be categorized into four major groups, mechanical problems, soft tissue conditions, inflammatory diseases and non-inflammatory diseases.

00:11:43
Conditions frequently associated with joint pain include osteoarthritis, tendonitis, infection, gout, rheumatoid arthritis and systemic lupus.

00:11:53
A number of presentations are indications of urgent problems requiring immediate recognition and definitive treatment.

00:12:00
[BLANK_AUDIO]

10.1 Nine Conditions You Do Not Want to Miss

Effects
00:00:00
[MUSIC]

00:00:09
Okay, starting with lecture 10, 9 Conditions You Do Not Want to Miss.

00:00:13
[BLANK_AUDIO]

00:00:21
Objectives, so by the end of this lecture, you should be able to identify which red flags are not uncommon to encounter in patients with low back pain and describe why.

00:00:31
Identify the 9 conditions in the Do Not Want to Miss list of pathologies which are life threatening and may mimic other common disorders.

00:00:39
And describe why it's important for patients to complete an intake questionnaire.

00:00:43
[BLANK_AUDIO]

00:00:48
Do not want to miss.

00:00:49
Keep in mind that these are more common in adults, in the elderly, and in patients presenting to outpatient settings.

00:00:56
Beware of unremitting pain that's not made better or worse by anything, including changing positions.

00:01:03
So the nine conditions highlighted in this chapter from your textbook are more common in adults, especially in older older adults and those adults seen in ambulatory settings.

00:01:13
So what this means is that for PTs working with children or working in an inpatient setting, this list of nine conditions would probably include some different conditions.

00:01:23
The point is that all practitioners should have a list of conditions to be extra vigilant for, and know those conditions to a greater depth than others.

00:01:32
[BLANK_AUDIO]

00:01:37
Low back pain.

00:01:38
So this table is taken from an article on low back pain, and it's an example of the information you should collect from patients presenting to you with complaints of low back pain.

00:01:49
These specific items are particularly important because they may suggest that your patient's low back pain may be caused by another medical condition which is mimicking mechanical low back pain.

00:02:02
The goal of red flags is to identify patients who have a higher probability of having a serious underlying medical condition and referring these patients to a physician for further examination to rule out serious medical issues that may not be treatable by standard physical therapy treatment.

00:02:19
There is some evidence that you will be referred a patient with low back pain who has not been thoroughly screened for red flags.

00:02:26
Two studies have demonstrated that primary care physicians asked about one-half to one-third of red flag identifying questions.

00:02:36
In one study, only 27% of the red flag history questions were asked to patients who presented with low back pain.

00:02:43
[BLANK_AUDIO]

00:02:50
It's also important to keep in mind, though, that some findings that we call red flags are common.

00:02:57
So some red flags are not an uncommon thing to stumble across.

00:03:02
For example, of the 159 patient charts asking patients with low back pain whether they suffer from night or constant pain in this study, 71 of them noted a positive response.

00:03:15
This doesn't mean that 71 of those 159 patients were immediately referred to their primary care provider.

00:03:22
Instead, this finding is noted as important and is weighted along with the rest of the findings from the examination.

00:03:30
So the specificity of quote, aged 50 and over unquote, or trauma or night constant pain in this sample of patients is not high for identifying serious underlying pathology in patients with low back pain, but it should not be ignored.

00:03:47
The regular and consistent use of a thorough patient intake questionnaire form will be extremely helpful for comprehensively documenting meaningful findings including red flags.

00:03:58
[BLANK_AUDIO]

00:04:04
So the Do Not Want To Miss List of nine conditions is in your textbook.

00:04:09
These are nine disorders,

00:04:11
[BLANK_AUDIO]

00:04:14
And they carry a high mortality risk and a high morbidity risk.

00:04:19
These conditions can also be difficult to differentiate from other conditions, and therefore difficult to diagnose.

00:04:26
Physical therapists are in an excellent position to detect clinical red flags and make timely referrals.

00:04:32
[BLANK_AUDIO]

10.2 Conditions 1 and 2

00:00:02
So lecture ten to Conditions 1&2, Major Depressive Disorder and Suicidal Risk.

00:00:08
[BLANK_AUDIO]

00:00:12
You should be able to describe the prevalence of major depressive disorder in adults.

00:00:16
Identify 2 questions that can help you decide whether to refer a patient for consult.

00:00:22
Identify a patient questionnaire helpful when screening patients for major depressive disorder.

00:00:27
Discuss which patient groups historically are at higher risk of committing suicide.

00:00:32
And identify factors associated with increased suicide risk and what questions might elucidate this information

00:00:39
[BLANK_AUDIO]

00:00:42
Major depressive disorder.

00:00:44
The prevalence is as high as 13% for adults.

00:00:48
Half of those will experience remission, but half of these will relapse the following year.

00:00:54
Refer to your Boissonnault book Box 20.2 for important risk factors.

00:01:00
A 2-question initial screening is recommended, so box 20.2 in your text provides a list of risk factors related to major depressive disorder.

00:01:10
In a 2017 study, only 18% physical therapists in this study screened their patients for depressive disorder.

00:01:18
[BLANK_AUDIO]

00:01:24
Major Depressive Disorder Screening.

00:01:27
[BLANK_AUDIO]

00:01:30
To meet the criteria for major depressive episodes, an individual must have symptoms over a two-week period that represent a change from previous functioning, with at least one of the symptoms being a depressed mood or loss of interest or pleasure.

00:01:43
The mnemonic SIGECAPS is helpful for remembering criteria for depression.

00:01:47
[BLANK_AUDIO]

00:01:51
A depressed mood most of the day nearly every day, as indicated by either subjective report or an observation made by others, is criteria number one.

00:02:01
Markedly diminished interest or pleasure and all or almost all activities most of the day nearly every day is criteria two.

00:02:08
Criteria three is significant weight loss when not dieting, weight gain, or a decrease or increase in appetite nearly every day.

00:02:17
In children consider failure to make expected weight gains.

00:02:20
That's criteria three.

00:02:21
Criteria four is insomnia, or hypersomnia nearly every day.

00:02:26
So inability to sleep, or sleeping excessively.

00:02:30
Number five is psychomotor agitation or retardation nearly every day.

00:02:34
Observable by others, not merely subjective feelings of restlessness or being slowed down.

00:02:40
Number six is fatigue, or loss of energy nearly every day.

00:02:44
Number seven, feelings of worthlessness or excessive or inappropriate guilt nearly every day.

00:02:52
Number eight is diminished ability to think or concentrate or indecisiveness nearly every day.

00:02:58
And number nine is recurrent thoughts of death, not just fear of dying, recurrent suicidal ideation without a specific plan for a suicidal attempt or a specific plan for committing suicide.

00:03:10
[BLANK_AUDIO]

00:03:15
A two question initial screening is recommended with a positive response leading to additional screening.

00:03:22
This screening tool asks the following questions.

00:03:25
Over the past two weeks have you felt down, depressed or hopeless and or little interest or pleasure in doing things?

00:03:35
A positive response carries a sensitivity of 96 and a specificity of 57.

00:03:43
A flowchart for PTS showing the sequence of screening questions is above.

00:03:49
Because of the high sensitivity value associated with the initial two questions, and no response to both, especially in an individual without a history of depression in the past year, makes it very

unlikely a major depressive episode is present.

00:04:03
Because of the low specificity value, a yes response is not diagnostic, but requires that additional patient information to be collected.

00:04:11
[BLANK_AUDIO]

00:04:21
Additional Information for Recognizing Major Depressive Disorder.

00:04:24
Major depressive disorder is the most common mental health condition seen in primary care.

00:04:30
The presentation may include mood, cognitive, neurovegetative, or somatic symptoms.

00:04:37
There are limited harms associated with screening, as long as a positive screen is followed up on.

00:04:42
The Patient Health Questionnaire-2 is a recommended questionnaire to use with these patients

00:04:47
[BLANK_AUDIO]

00:04:53
And this is the Patient Health Questionnaire-2.

00:04:55
We can see that the questions are located in the top half and the scoring is the bottom half.

00:05:01
And based on the score, we can assess the probability of major depressive disorder.

00:05:06
[BLANK_AUDIO]

00:05:16
Condition number two, suicide risk.

00:05:18

In 2017, around 500,000 people saw care related to this in emergency departments.

00:05:26
Among ages 15 to 24, suicide is the third leading cause of death.

00:05:31
Men aged 65 years or older are the group at highest risk for completed suicides.

00:05:37
Prevalence of up to 4% of patients in primary care settings.

00:05:42
See box 23 in your textbook for important risk factors.

00:05:45
[BLANK_AUDIO]

00:05:47
So in addition, 50 to 67% of individuals committing suicide will have seen a physician within four weeks of the act.

00:05:55
The global suicide rate is 12 per 100,000 individuals making suicide the 14th leading cause of global mortality.

00:06:03
The suicide rate in the United States is more than 15 per 100,000 individuals, making suicide the tenth leading cause of death.

00:06:10
[BLANK_AUDIO]

00:06:14
Suicide risk screening.

00:06:17
So an important factor is a sense of hopelessness or a sense of giving up on the patient.

00:06:23
Thoughts of death, 100% sensitivity and 81% specificity.

00:06:28
Patients wishing they were dead, 92% sensitivity and 93 specificity.

00:06:34
Be aware that most patients will not volunteer this information.

00:06:38
Asking patients whether they are or have been thinking of self-harm is critical.

00:06:42
If they answer yes, you should initiate the facility protocol if there is one, including referral immediately.

00:06:50
Race is also a factor, with approximately 75% of completed suicides involving white men.

00:06:57
Estimates are that approximately 90% of those committing suicide have a history of psychiatric illness, with most having major depression.

00:07:05
[BLANK_AUDIO]

00:07:08
Another factor associated with suicide is alcohol abuse.

00:07:13
If a patient responds yes to the question of having thoughts of attempting to harm himself or herself, the clinician should initiate the facility's protocol as I noted above.

00:07:23
This should include important follow-up questions regarding whether the patient has a plan in place, whether resources related to the patient's plan are readily available, for example, does the patient own a gun, does the patient have a filled medication, prescription, etc.

00:07:38
And the PT should also be aware of who they should contact regarding this information.

00:07:44
[BLANK_AUDIO]

00:07:50
Additional information regarding suicide risk, questions for assessing suicide risk.

00:07:56
Have you been thinking that you would be better off dead or wishing that you were dead?

00:07:59

Do you have thoughts of harming yourself?

00:08:01
Have you been thinking about suicide?

00:08:04
If you've been thinking about suicide, do you have a plan?

00:08:06
If so, describe the plan.

00:08:08
Have you recently attempted suicide?

00:08:10
In the past, have you thought about or attempted suicide?

00:08:14
If the responses identify a detailed plan for ending life, a lack of hope that things can get better in the future, or an inability to identify reasons for not dying, for example not wanting to leave loved ones, is considered a psychiatric emergency requiring immediate intervention and referral.

00:08:30
[BLANK_AUDIO]

10.3 Conditions 3, 4, 5

00:00:02
Lecture 10.3, conditions three, four and five, femoral head and neck fracture, cauda equina syndrome, and cervical myelopathy.

00:00:11
[BLANK_AUDIO]

00:00:16
Objectives, by the end of this lecture, you should be able to identify risk factors for femoral head and neck fractures.

00:00:23
You should describe how femoral head and neck fractures may present in the clinic.

00:00:28
You should be able to describe two physical examination tests, which may be useful for identifying femoral head and neck fractures.

00:00:36
You should define Cauda Equina Syndrome and describe how a patient with this pathology may present clinically.

00:00:43
You should be able to identify red flags, specific to Cauda equina syndrome.

00:00:47
You should be able to define cervical myelopathy and describe how a patient with this pathology may present clinically.

00:00:55
You should be able to identify the three components of diagnosing cervical myelopathy and identify four disorders which may present like cervical myelopathy.

00:01:06
[BLANK_AUDIO]

00:01:07
Femoral head and neck fractures.

00:01:10
So femoral head and neck fractures lead to increased morbidity, mortality, and Healthcare issues.

00:01:19
Risk factors include, osteoporosis and falls, low socioeconomic status

cardiovascular disease, Endocrine disorders, certain medications, and a low BMI.

00:01:31
Fall prevention and treatment of osteoporosis are paramount.

00:01:35
The relevance of femoral head and neck fractures, is that once the injury occurs there is significant morbidity, mortality, and health care issues.

00:01:44
Referral for diagnostic imaging can prevent a non-displaced fracture from progressing to a displaced fracture, which, if it occurs, then typically requires surgical intervention.

00:01:55
It's estimated that approximately 30-60% of community-dwelling older adults fall each year.

00:02:02
Approximately 90% of hip fractures in older patients occur from a simple fall from the standing position.

00:02:08
Women sustain hip fractures more often due to their higher rates of osteoporosis.

00:02:13
The lifetime risk of hip fracture is 17.5% for women and 6% for men.

00:02:20
On average, women who sustain a femoral neck fracture are 77 years old and men are 72 years old.

00:02:26
[BLANK_AUDIO]

00:02:33
Screening for femoral head and neck fractures.

00:02:36
So pain and local tenderness may be associated with the femoral head and neck fracture, particularly in the groin, trochanteric and/or buttock regions.

00:02:44
There may be at the presence of deformity including a shortened limb, edema, ecchymosis, loss of function and mobility, including weight bearing.

00:02:52
And fracture is not always associated with a fall or major trauma.

00:02:57
There may or may not be ecchymosis or edema and palpatory tenderness while common is not necessary.

00:03:04
The common deformity includes a shortened limb, with the position of comfort being limb external rotation and abduction.

00:03:12
If you strongly suspect a fracture, urgent referral is warranted.

00:03:16
A non-displaced femoral head or neck fracture can have a more confusing and much less severe presentation.

00:03:23
Resulting in a delay in diagnosis, placing the individual at high risk for progression to a displaced fracture.

00:03:29
[BLANK_AUDIO]

00:03:34
Additional information for femoral head neck fractures continued.

00:03:37
Please look at your textbook box 20.4 and 20.5 for important risk factors, you should be more vigilant in older patients with a history of reduced bone mineral density.

00:03:52
You should watch for pain with weight-bearing, and pain that's relieved immediately in non-weight-bearing positions.

00:03:58
There may be no pain during range of motion testing.

00:04:01
The patellar pubic percussion test may be useful.

00:04:04
And also, the fulcrum test may be a useful screen.

00:04:07
[BLANK_AUDIO]

00:04:12
So this slide is a picture of the patellar-pubic percussion test.

00:04:17
The patient is comfortably positioned supine, and the legs are placed in a symmetric position.

00:04:23
The head of the stethoscope is positioned in the midline on the pubic symphysis.

00:04:27
The therapist holds the patella in place and percusses sharply on the patella.

00:04:33
The involved limb should produce a duller sound versus the limb that is not fractured.

00:04:38
[BLANK_AUDIO]

00:04:46
Condition for Cauda equina syndrome.

00:04:48
The Cauda equina syndrome is caused by an intra spinal lesion coddled to the CONUS that injures two or more of the 18 nerve roots constituting the cauda acquired within the lumbar spinal canal.

00:05:00
It's typically associated with Martin neurologic disability.

00:05:04
The clinical presentation is dominated by bilateral leg weakness and multiple root distributions.

00:05:09
And may be associated with perennial century symptoms as well as bowel, bladder, sexual dysfunction due to involvement on the S2-4 spinal nerve roots.

00:05:21
Potential etiology due to developmental abnormalities such as neural tube defects, infectious, or inflammatory conditions or [UNKNOWN] such as tumors.

00:05:30
[BLANK_AUDIO]

00:05:36
Screening of Cauda Equina Syndrome.

00:05:39
Risk factors include low back injury, spinal stenosis, spinal fracture, ankylosis spondylitis, tuberculosis, and pott`s disease.

00:05:49
Refer to your textbook Box 20.6.

00:05:51
[BLANK_AUDIO].

00:05:54
In a patient who you suspect may have Cauda equina syndrome, you should note gait ataxia or balance deficits or complaints of heavy legs.

00:06:03
Bowel, bladder, or sexual dysfunction should be noted.

00:06:06
Urinary retention may be the most frequent symptom.

00:06:09
The onset of Cauda equina syndrome could be sudden and alarming for patients.

00:06:15
Many conditions increase the risk of Cauda Equina Syndrome.

00:06:18
Tuberculosis can produce a myelopathy by different mechanisms.

00:06:22
Infection of the vertebral body leads to tuberculosis spondylitis or Pott's disease, which can lead to secondary cord compression.

00:06:29
These patients present with back pain over the affected vertebrae.

00:06:33
A low grade fever and weight loss followed by a secondary compressive myelopathy.

00:06:37
[BLANK_AUDIO]

00:06:51
So within this cluster of red flags, the red flags that have an

asterisk next to them are specific to Cauda Equina Syndrome.

00:07:00
And so those include difficulty with micturition, loss of anal sphincter tone or fecal incontinence, saddle anesthesia, and gait disturbance.

00:07:09
[BLANK_AUDIO]

00:07:20
Condition number five, Cervical Myelopathy.

00:07:23
This is a mechanical compression of neural elements within the central cervical canal.

00:07:29
The primary symptoms tend to be neurologic versus pain.

00:07:33
Symptoms usually progress over time, but they can be stable for periods.

00:07:36
Myelopathy occurs in 5% to 10% of patients with cervical spondylosis.

00:07:41
[BLANK_AUDIO]

00:07:44
Generally, degenerative changes in the cervical spine can lead to narrowing of the cervical canal.

00:07:49
Which can produce dysfunction of the spinal cord due to compression.

00:07:53
The process can damaged nerve roots as well as the cord itself, injury to the anterior horn cells can actually cause lower motor neuron deficits.

00:08:01
[BLANK_AUDIO]

00:08:09
Screening for cervical myelopathy.

00:08:12
Risk factors include, age 50s to 60s, of previous diagnosis of

cervical spondylosis.

00:08:19
Also, look at your text in box 20.7.

00:08:23
With these patients, note hand impairment, gait impairment, or balance disturbances.

00:08:28
Also, look for subtle signs of neurologic compromise, numbness, or paresthesia, as well as neck stiffness or urinary dysfunction.

00:08:37
The diagnosis is really made based on a correlation between the history, the physical exam, and the imaging studies.

00:08:44
There is no well-defined pattern of neurologic deficits.

00:08:48
It could include pain in the neck subscapular region, arms, numbness or paresthesias in the arms.

00:08:54
Possible loss of fine motor control, gait disturbance, sensory deficits such as loss of pain sensation, upper motor neuron signs, lower extremity weakness, hyperreflexia, babinski Sign.

00:09:07
Lower motor neuron signs, such as possible suppress reflexes, weakness atrophy, bladder dysfunction.

00:09:16
Symptoms usually begin insidiously.

00:09:19
Gait impairment is a common early symptom.

00:09:22
This is often ill described by the patient who may complain of blade weakness or stiffness, or even complain of a vague unsteadiness.

00:09:29
[BLANK_AUDIO]

00:09:30
Patients with cervical spondylotic myelopathy may present with progressive bilateral sensory loss and motor dysfunction in the hands without other neurologic symptoms.

00:09:40
[BLANK_AUDIO]

00:09:41
Some patients with myelopathy will present acutely, often after minor neck trauma such as from a fall.

00:09:49
With a central cord syndrome, characterized by disproportionately greater motor impairment.

00:09:54
And upper compared with the lower extremities, bladder dysfunction and a variable degree of sensory loss below the level of the injury.

00:10:01
[BLANK_AUDIO]

00:10:06
What you're seeing here in this image, on the right side of the screen here is that chord compression responsible for the myelopathy.

00:10:17
[BLANK_AUDIO]

00:10:24
Differentials, or differential diagnoses from cervical myelopathy include ALS amyotropic lateral sclerosis.

00:10:32
Cervical myelopathy lower motor neuron deficits are isolated to cervical myotomes, and then also other cervical disorders.

00:10:40
Other pathologies can produce similar symptoms.

00:10:42
Guillain-Barre syndrome.

00:10:46
Patients with myelopathy usually have hyperreflexia and do not have cranial nerve involvement.

00:10:52
Normal pressure hydrocephalus, cervical myelopathy is generally not associated with cognitive dysfunction ALS and cervical myelopathy both person present in older adults.

00:11:04

A neurological exam demonstrates both upper and lower motor neuron deficits.

00:11:09
With cervical myelopathy, lower motor neuron deficits and FAS stipulations are isolated to the affected cervical myotomes.

00:11:16
But in ALS, they often appear in the legs and cranial muscles.

00:11:20
Guillain-Barré and myelopathy can both present as a subacute progressive paraparesis or quadriparesis.

00:11:28
Patients with Guillain-Barré typically have reduced or absent reflexes and may have cranial nerve involvement.

00:11:35
While patients with myelopathy usually have hyperreflexia and do not have cranial nerve involvement.

00:11:41
[BLANK_AUDIO]

00:11:49
So we see here, looking at cervical myelopathy up here, that age is usually over 60.

00:11:54
It's usually progressive or stepwise course.

00:11:59
Moderate severe cases demonstrate gait and leg spasticity or amyotrophy of the hand or arms.

00:12:05
I mean diagnosis, the gold standard is generally MRI of the cervical spine.

00:12:10
And then down here we look at ALS, again usually over 60 years progressive and this is pure motor syndrome, and the diagnosis is made via electromyography

00:12:23
[BLANK_AUDIO]

10.4 Conditions 6 and 7

00:00:01
This is lecture 10.4, conditions 6 and 7 for the nine conditions we don't want to miss.

00:00:07
And those 6 and 7 include abdominal aortic aneurysm and deep vein thrombosis.

00:00:13
[BLANK_AUDIO]

00:00:18
After this lecture you should be able to define abdominal aortic aneurysm and describe risk factors associated with it.

00:00:25
You should be able to describe how a patient suffering from an abdominal aortic aneurysm may present clinically.

00:00:32
You should be able to describe how to screen a patient you suspect is suffering from abdominal aortic aneurysm, including palpation.

00:00:40
You should be able to define deep vein thrombosis and describe risk factors associated with DVT.

00:00:45
And define wells and modified wells score and how to screen a patient you suspect may have a DVT.

00:00:51
[BLANK_AUDIO]

00:00:58
Abdominal aortic aneurysm.

00:01:00
An aneurysm is a bulge or ballooning, and in the case of abdominal aortic aneurysm, it's a bulge or ballooning of the abdominal aortic artery.

00:01:10
Surgery carries a 4.2% risk of mortality and a 32% complication rate.

00:01:15
The abdominal aortic aneurysm, or AAA, usually occurs in individuals age 60 and older.

00:01:22
The typical complaint is back pain.

00:01:24
[BLANK_AUDIO]

00:01:30
An abdominal aortic aneurysm is an abnormal focal dilation of the abdominal aorta.

00:01:35
It's often asymptomatic, but it's discovered by palpating a pulsatile mass during physical examination.

00:01:42
Imaging confirmation is required for making the diagnosis.

00:01:47
In this image on the right, the patient was referred to CT to scan to exclude an aortic dissection.

00:01:55
Little did the patient know, contained rupture of a previously unknown abdominal aortic aneurysm was diagnosed.

00:02:03
[BLANK_AUDIO]

00:02:06
Surgery was performed and the patient walked home two weeks later.

00:02:11
Ruptured aneurysms present with severe abdominal or back pain and hypotension or shock.

00:02:16
The mortality rate from a ruptured abdominal aortic aneurysm is high, 59% to 83% of patients die before they make it to the hospital or undergo surgery.

00:02:26
As noted above, the operative mortality rate for those who do make it to surgery is also high.

00:02:34
[BLANK_AUDIO]

00:02:38
All right, so this is a pain location drawing from a real case, and I

want you to note the location and description of the patient's symptoms.

00:02:47
So the patient described these symptoms here as constant, and they're varying from bloated feeling with intermittent sharp and stabbing sensations.

00:02:57
In their low back they describe a constant varying, deep, dull ache with intermittent throbbing sensations.

00:03:03
[BLANK_AUDIO]

00:03:05
.And this was at the patient's initial physical therapy visit before they were diagnosed with the abdominal aortic aneurysm.

00:03:11
[BLANK_AUDIO]

00:03:18
Characteristics of abdominal aortic aneurysms.

00:03:21
Most individuals with abdominal aortic aneurysm have no symptoms.

00:03:27
Risk factors are age, male sex, cigarette smoking, and hypertension.

00:03:32
Also, trauma, syphilis, Marfan's-Ehlers-Danlos, and other connective tissue disorders, as well as a history of an aneurysm.

00:03:40
See Box 20.8 in your textbook.

00:03:43
[BLANK_AUDIO]

00:03:46
When palpating the abdomen, a prominent lateral pulsation can give you a clue that there may be an underlying abdominal aortic aneurysm.

00:03:56
To perform this palpation, the patient lies supine and the examiner places the fingertips over the epigastrium to determine if a pulse is present.

00:04:04
Both hands are placed on either side of the aorta to help determine the aortic width.

00:04:09
A positive test is that the abdominal aorta is greater than three centimeters in width.

00:04:17
So age and male gender are important risk factors because the prevalence of AAA is five to six times greater in men than women.

00:04:25
A history of smoking carries at three to five times greater risk for developing a AAA.

00:04:30
The effect of smoking plus age consideration was demonstrated by a study inviting men aged 65 to 74 years of age, with a lifetime consumption of smoking more than 100 cigarettes into AAA screening.

00:04:43
It was estimated that eliminating the smoking would result in 89% reduction in abdominal aortic aneurysm related deaths in this age group.

00:04:53
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00:04:59
So palpation for abdominal aortic aneurysm has a sensitivity of 68 and a specificity of 75 likelihood ratio of 2.7.

00:05:09
And accuracy is improved by smaller patient waist size and larger aneurysm size.

00:05:15
The ability to palpate will depend on the patient's body morphology.

00:05:19
Detecting a AAA with palpation, again, is a 68 percent sensitivity.

00:05:24
A waist size less than 100 centimetres and larger aneurysms, meaning aneurysms greater than 5 centimetres, increase the sensitivity.

00:05:32
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00:05:34
So once a pulse has been detected with mid abdominal palpation, the PT places fingertips with deep and gentle pressure along the sides of the pulse, noting the presence of a laterally expansive pulsation.

00:05:47
Such a finding what further worn abdominal auscultation are brewing keep in mind the sensitivity on this is not great and very dependent on body morphology.

00:05:58
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00:06:05
Deep vein thrombosis.

00:06:07
Consider a vascular origin for any leg pain that is not musculoskeletal in nature.

00:06:13
A patient with arterial insufficiency may describe pain that increases with exercise and decreases with rest.

00:06:20
A patient who may be suffering from venous insufficiently may describe pain as gradual and onset.

00:06:26
It may be delayed, and may have greater variability.

00:06:29
It could be constant from hours to days.

00:06:32
It also may be life-threatening in the form of thrombophlebitis, or pulmonary embolism.

00:06:38
50% of DVTs are asymptomatic in the early stages.

00:06:43
Pain or weakness that occurs in the calves and sometimes the thighs or the buttocks with exercise and then dissipates at rest is most likely related to peripheral vascular disease.

00:06:56
Intermittent claudication is pain that comes on rapidly during exercise and then is relieved by rest.

00:07:01
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00:07:05
In your textbook, please see box 20.9 for DVT risk factors.

00:07:10
And we can see on the table on the right here that there are a number of causes for the development of venous thrombosis.

00:07:20
[BLANK_AUDIO]

00:07:22
Regarding the history, it's very important to ask if there's a history of previous blood clots in the lower extremities.

00:07:29
Ask about other blood clotting disorders, recent trauma to the legs, history of abdominal cancers, prolonged immobility or travel, cardiovascular or cerebrovascular disease, chronic spinal conditions, paraesthesia.

00:07:43
Lower extremity weakness or calf pain, especially during walking or exercise.

00:07:49
Physical examination should include examination of temperature, color, condition of the skin, the presence of arterial pulses and the lower extremities, calf redness or edema.

00:08:01
Sensation testing reflexes and note any discomfort with ambulation.

00:08:06
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00:08:11
So again for the physical examination, and a patient you suspect may be suffering from a DVT.

00:08:17
Assess the temperature, color and condition of the skin, assess the presence of pulses in the lower extremities.

00:08:24
Look for calf redness or edema.

00:08:26

Test sensation and reflexes and note any discomfort with ambulation.

00:08:31
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00:08:39
The Wells' criteria for DVT You should only apply the Wells criteria after the history and physical examination is suggestive of a DVT.

00:08:48
Recognize the importance of pretest probability, unilateral leg pain, redness, swelling, edema, warmth, tenderness.

00:08:57
Age over 55 and history of bed rest or immobility all increase the probability.

00:09:03
In terms of physical findings, a difference in calf circumference, dilated superficial veins, unilateral warmth, tenderness, erythema, pain and tenderness along the course of involved major veins and local mass.

00:09:18
Or signs of malignancy are also suggestive of DVT.

00:09:23
From Dr. Wells regarding his scores, the model should be applied only after a history and physical suggests that DVT is a diagnostic possibility.

00:09:32
It should not be applied to all patients with chest pain or dyspnea or all patients with leg pain or swelling.

00:09:39
This is the most common mistake that's made with the Wells criteria.

00:09:43
A larger calf circumference is the most usual finding.

00:09:46
One meta-analysis reported that patients with a difference in calf circumference were twice as likely to have a DVT.

00:09:54
Holman's sign, calf pain on passive dorsiflexion of the foot, is unreliable for the presence of DVT.

00:10:01

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00:10:06
So this is the Wells score.

00:10:09
And we can see clinical features are each given a score of one at their present.

00:10:13
So active cancer, paralysis, creases or recent plaster immobilization of the lower extremities.

00:10:19
Recently bedridden for more than three days or major surgery within four weeks, localized tenderness along the distribution of the deep venous system, entire swelling of a leg.

00:10:29
Calf swelling by more than three centimeters when compared to the asymptomatic leg.

00:10:36
Pitting, edema, collateral, superficial veins, and an alternative diagnosis as likely or more likely than that of DVT would result in subtracting two points.

00:10:46
And then this results in suspicion of high probability, moderate probability, or low probability.

00:10:54
There's also a modification here.

00:10:56
And that modification includes taking into account a previously documented DBT.

00:11:04
So patients may be assigned to one of three risk categories, high, moderate, and low, but it's also acceptable to use two categories, unlikely or likely.

00:11:14
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