Chapter 15

The Spine

Introduction

This chapter provides criteria for evaluating permanent impairments of the spine, including how they affect an individual's ability to perform activities of daily living (ADL). The spine consists of four regions: the cervical, thoracic, lumbar and sacral vertebrae, and associated soft tissues including muscles, ligaments, disks, and neural elements. Impairments of the spine discussed in this chapter include lumbar, thoracic, cervical, spinal cord, and pelvic impairments.

The following revisions have been made for the fifth edition: (1) The use of the diagnosis-related estimate (DRE) and range-of-motion (ROM) methods has been modified, and applications are described in greater detail; (2) impairment is rated only when the individual has reached maximal medical improvement (MMI); (3) impairments within a DRE category encompass a range, with adjustments of up to 3%; (4) spinal cord injury is evaluated according to the functional approach in the nervous system chapter; (5) the "differentiators" in the fourth edition have been replaced by "objective findings" and are more specifically defined; and (6) alterations of motion segment integrity have been redefined to reflect current scientific knowledge.

As in the fourth edition,[1] *the DRE method is the primary method used to evaluate individuals with an injury. Use the ROM method when the impairment is not caused by an injury or when an individual's condition is not well represented by a DRE category. The ROM method is also now used to evaluate individuals with an injury at more than one level in the same spinal region and in certain individuals with recurrent pathology*. This approach addresses the difficulty of assigning these individuals to an appropriate DRE category. An exception, however, is individuals with corticospinal involvement who have been treated with decompression and multilevel fusions within the same region; they should be rated by the DRE method because assessing ROM in paralyzed individuals is difficult. Finally, the range-of-motion method should be used if statutorily mandated in a particular jurisdiction. A more detailed description of the applications of either method is provided in Section 15.2.

As stated in this edition, an individual with a spinal condition is rated only when the condition is stable (unlikely to change within the next year regardless of treatment), ie, when MMI has been reached (Chapter 1 and Glossary). The individual is evaluated based on medical findings that are present when MMI has been reached.

15.1 Principles of Assessment

Before using the information in this chapter, the *Guides* user should become familiar with Chapters 1 and 2 and the Glossary. Chapters 1 and 2 discuss the *Guides'* purpose, applications, and methods for performing and reporting impairment evaluations. The Glossary provides definitions of common terms used by many specialties in impairment evaluation.

The evaluation should include a comprehensive, accurate medical history; a review of all pertinent records; a comprehensive description of the individual's current symptoms and their relationship to daily activities; a careful and thorough physical examination; and all findings of relevant laboratory, radiologic (imaging), electrodiagnostic, and ancillary tests. It is also essential that the rater include in the report a description of how the impairment was calculated. Because many ratings are reviewed by other physicians and nonmedical personnel, the explanation of the calculation will lead to a better understanding of the method used and the report will be considered more reliable and complete.

15.1a Interpretation of Symptoms and Signs

History

The history should be based primarily on the individual's own statements rather than secondhand information. While the medical history should consider information from others, the physician should be cautious about using subjective information from medical records. It is not appropriate to question the individual's integrity. If information from the individual is inconsistent with what is known about the medical condition, circumstances, or written records, the physician should report and comment on the inconsistencies.

The history must describe in detail the chief complaint and the quality, severity, anatomic location, frequency, and duration of symptoms, including pain, numbness, paresthesias, and weakness. Document exacerbating and alleviating factors and the way in which the condition interferes with daily activities. The physician should elicit the history of when and how the condition started, any precipitating events or factors, and the relationship to any previous spine problems.[2-4]

The history should include the individual's description, in his or her own words, of how the symptoms developed and the assumed cause. In addition, the response to treatment and the results of special studies that have been performed should be described. The physician should either review available roentgenograms and other imaging studies personally or report the findings as being those of another reviewer (based on reports). A review of organ systems and of the general medical history can provide potentially helpful information, including complicating medical problems that can affect the diagnosis, treatment plan, prognosis, disability, etc.

Examination

Physical examination of nonmusculoskeletal areas (eg, nervous system) is discussed in other parts of the *Guides*. Since a targeted neurologic assessment is needed for individuals with back or neck problems, the physician must have a good grasp of basic neurologic examination techniques and principles. Guided by the history, the physician should focus on spine-related physical findings, such as range of motion, reflexes, muscle strength and atrophy, sensory deficits, root tension signs, gait, and the need for assistive devices (Table 15-1). Range-of-motion measurements are discussed later in this chapter.

Table 15-1 Physical Examination

Lumbar Spine

Individual Position	Examination
Standing	Posture Scoliosis Lordosis Kyphosis
	Palpation Muscles Tenderness
	Gait
	Range of motion
	Muscle strength screening Heel-toe walk Squatting
Sitting	Neurologic Reflexes (ankle, knee) Strength Sensation
	Nerve tension Straight leg raising (or similar)
Recumbent Supine	Neurologic Reflexes Strength Sensation Straight leg raising (or similar)
	Other Pulses Hip range of motion
Recumbent Prone	Nerve tension Femoral stretch test
	Palpation Muscles Spinous processes

Thoracic Spine

Individual Position	Examination
Standing	Posture Scoliosis Kyphosis
	Palpation Muscles Tenderness
	Range of motion

Cervical Spine

Individual Position	Examination
Standing or sitting	Posture Scoliosis Kyphosis Lordosis
	Palpation Muscles Tenderness
	Range of motion
	Other Shoulder motion Cervical compression Foraminal compression (Spurling test)
	Neurologic Reflexes (biceps, triceps, brachioradialis, finger) Motor Sensory

The physical examination of the spine must be placed in the context of the individual's general health and condition. For findings such as atrophy, consider other possible explanations besides spine impairment, such as previous joint surgery or hypertrophy of the contralateral side from overuse. Other physical conditions may be present that influence motor and sensory function, ranges of motion, and sciatic nerve tension. Examination of associated systems (vascular, nervous) and follow-up of any possibly significant information from the history and physical examination will allow the physician to distinguish between spine-related findings and other abnormalities.[2-4]

The physician should record and discuss any physical findings that are inconsistent with the history. Many physical findings are subjective, ie, potentially under the influence of the individual. It is important to appreciate this and not confuse such observations with truly objective findings.

It is not the purpose of this text to discuss in detail how the physical examination is performed; textbooks are available to cover that subject. A few aspects of particular value to the impairment evaluation will be discussed subsequently.

Evaluation of Sciatic Nerve Tension Signs

Sciatic nerve tension signs are important indicators of irritation of the lumbosacral nerve roots. While most commonly seen in individuals with a herniated lumbar disk, this is not always the case. In chronic nerve root compression due to spinal stenosis, tension signs are often absent. A variety of nerve tension signs have been described. The most commonly used is the straight leg raising test (SLR). When performed in the supine position, the hip is flexed with the knee extended. In the sitting position, with the hip flexed 90°, the knee is extended. The test is positive when thigh and/or leg pain along the appropriate dermatomal distribution is reproduced. The degree of elevation at which pain occurs is recorded.

Research indicates that the maximum movement of nerve roots occurs when the leg is at an angle of 20° to 70° relative to the trunk. However, this may vary depending on the individual's anatomy. Further, the L4, L5, and S1 nerve roots are those that primarily change their length when straight leg raising is performed. Thus, pathology at higher levels of the lumbar spine is often associated with a negative SLR. Root tension signs are most reliable when the pain is elicited in a dermatomal distribution. Back pain on

SLR is not a positive test. Hamstring tightness must also be differentiated from posterior thigh pain due to root tension.

With time, spine-related symptoms usually improve, and a positive root tension (SLR) test is elicited only at the extremes of hip flexion (leg raising). While straight leg raising in disk herniation is a relatively sensitive test (72% to 97%), it is nonspecific (11% to 45%).[5] Straight leg raising of the asymptomatic limb (eg, crossed SLR) that produces **sciatica** in the limb with symptoms (crossed positive) is a specific (85% to 100%) but less sensitive (23% to 42%) test.

Results of supine SLR can be further validated by recording the individual's response to gentle dorsiflexion and plantar flexion of the ankle, and to internal and external rotation of the hip when the straightened leg is raised to the point where symptoms begin. Normally, ankle dorsiflexion and hip internal rotation increase the pain, and ankle plantar flexion and hip external rotation decrease the sciatica. Since sitting knee extension and supine hip flexion culminate in essentially identical positions, symptomatic responses to the two types of SLR should be similar, although the angle at which pain is elicited may vary.

The reverse SLR or femoral stretch test causes root tension of L2, L3, and L4 and may be a sign of disk herniations at the higher levels. This test has low sensitivity and specificity.

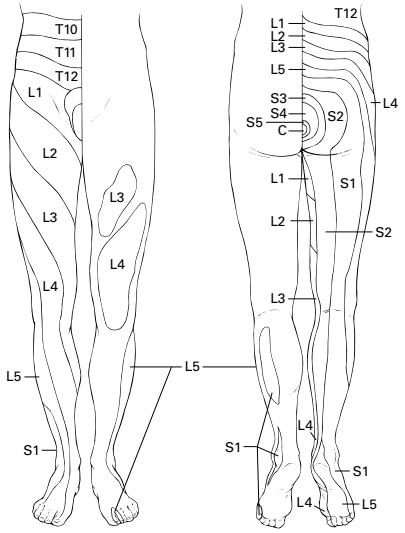
Neurologic Tests

Neurologic examination of the lower extremity should include measurement of knee and ankle reflexes and motor and sensory functions. Because over 90% of all nerve-related pathology in the lumbar spine occurs at the L3-4, L4-5, and L5-S1 levels, it is especially important to recognize the functions of the L4, L5, and S1 nerves (Table 15-2). The knee reflex is primarily a test of L4 nerve root function. Individuals with pathology at the L3-4 level may also have sensory changes in the L4 dermatome (Figure 15-1) and quadriceps weakness. L5 nerve root compression will often influence the strength of the extensor hallucis longus muscle, but other foot and ankle muscles can be affected as well, resulting in weakness in foot dorsiflexion and difficulty walking on the heels. The ankle reflex is primarily mediated by the S1 nerve root. Weakness in foot plantar flexion and difficulty with toe walking can also occur with S1 root compression. The Babinski sign and the presence of clonus and hyperreflexia are important indicators of corticospinal tract involvement.

Table 15-2 Common Radicular Syndromes

Disk Level	Nerve Root	Motor Deficit	Sensory Deficit	Reflex Compromise
Lumbar				
L3-4	L4	Quadriceps	Anterolateral thigh Anterior knee Medial leg and foot	Knee
L4-5	L5	Extensor hallucis longus	Lateral thigh Anterolateral leg Middorsal foot	Medial hamstrings
L5-S1	S1	Ankle plantar flexors	Posterior leg Lateral foot	Ankle
Cervical				
C4-5	C5	Deltoid Biceps	Anterolateral shoulder and arm	Biceps
C5-6	C6	Wrist extensors Biceps	Lateral forearm and hand Thumb	Brachioradialis Pronator teres
C6-7	C7	Wrist flexors Triceps Finger extensors	Middle finger	Triceps
C7-T1	C8	Finger flexors Hand intrinsics	Medial forearm and hand, ring and little fingers	None
T1-T2	T1	Hand intrinsics	Medial forearm	None

Figure 15-1 Skin Areas Innervated by the Thoracic and Lumbosacral Nerve Roots and Showing Autonomous Zones

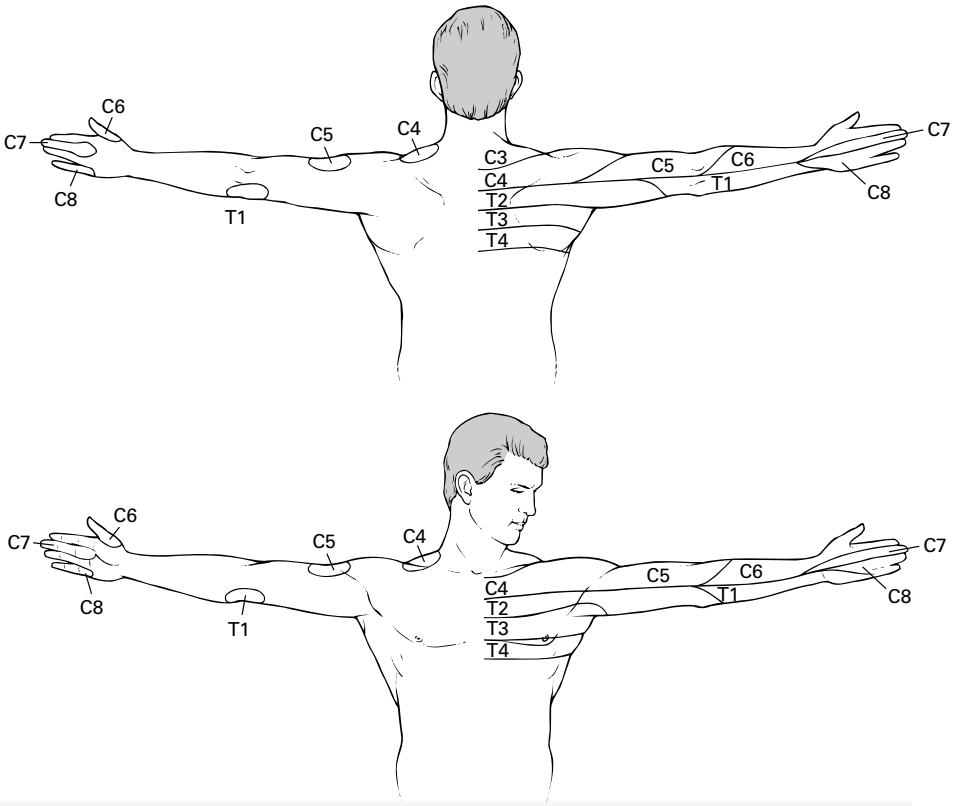


Changes in balance and gait pattern may also signify myelopathy.

A systematic neurologic examination can also localize the affected cervical nerve root (Table 15-2). The upper spine and extremity sensory dermatomes appear in Figure 15-2. The biceps (C5, partially C6), brachioradialis (C6), and triceps (C7) reflexes should be elicited. Weakness of the deltoid and biceps muscles implicates C5; wrist extensors C6; triceps, wrist flexors, and finger extensors C7; finger flexors C8; and intrinsics C8 and T1. Sensation can be grossly evaluated by touch and more precisely determined by pinprick, light touch, and a vibrating fork. Dermatomal overlap is common.

Reflexes should always be compared between extremities and elicited several times to determine reproducibility. Importantly, reflexes once "lost" due to previous injury or disease rarely return. Strength should also be compared between extremities and may need repeat testing to determine effort and reproducibility.

Figure 15-2 Skin Area Innervated by the Cervical and Thoracic Nerve Roots Showing Autonomous Zones



15.1b Description of Clinical Studies

General

The individual may have undergone a variety of special tests including electromyographic, cystometric, roentgenographic studies with or without dye, CT scans, and MRI studies with or without contrast. The physician should determine when, where, and by whom the studies were done, the findings, and who interpreted them. Whenever possible, the physician should personally review the studies and report agreement or disagreement with previous interpretations. A summary of the studies should be included as a separate paragraph or section.

While imaging and other studies may assist physicians in making a diagnosis, it is important to note that a positive imaging study in and of itself does not make the diagnosis. Several reports indicate approximately 30% of persons who have never had back pain will have an imaging study that can be interpreted as positive for a herniated disk, and 50% or more will have bulging disks. Further, the prevalence of degeneration changes, bulges, and herniations increases with advancing age.[6-11] To be of diagnostic value, clinical symptoms and signs must agree with the imaging findings. In other words, an imaging test is useful to confirm a diagnosis, but an imaging result alone is insufficient to qualify for a DRE category. Individuals with electromyography (EMG) studies that are clearly positive support a diagnosis of radiculopathy and therefore qualify for at least DRE category III.[14]

Motion Segment Integrity

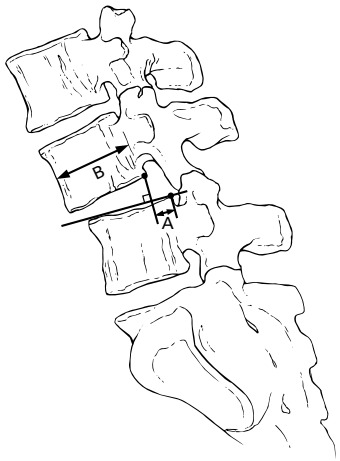
A motion segment of the spine is defined as two adjacent vertebrae, the intervertebral disk, the apophyseal or facet joints, and ligamentous structures between the vertebrae. The range of motion from segment to segment varies. In the upper cervical spine (occiput to C2), there is little flexion-extension, while the lower cervical spine permits increasing flexion-extension movements from about 10° at C2 to C3 to about 20° at C5 to C6 and C6 to C7. Flexion-extension movements are about 4° in the upper thoracic spine, 6° in the midthoracic spine, and 12° in the lower thoracic spine segments. In the lumbar spine there is a gradual increase from about 12° at L1 to L2 to 20° at the L5 to S1 level.[13]

Lateral bending is 5° to 6° in the lower cervical spine and about 6° in the upper thoracic spine. In the lumbar spine, lateral bending is greatest at L3 to L4, where it is about 8° to 9°. Axial rotation is 30° to 40° in each direction in the upper cervical spine, 5° to 6° in the lower cervical and upper thoracic spine, and minimal in the lumbar spine.

Throughout the spine, movements are coupled; this means that the primary motion in one direction always is accompanied by a secondary motion in another direction. For example, rotation is almost always combined with side bending. The dominant motions at both the lower cervical and entire lumbar spine, where most clinical pathology occurs, are flexion-extension.

Alteration of motion segment integrity can be either loss of motion segment integrity (increased translational or angular motion) or decreased motion resulting mainly from developmental changes, fusion, fracture healing, healed infection, or surgical arthrodesis. An attempt at arthrodesis may not necessarily result in a solid fusion, but it may significantly limit motion at a motion segment and qualify for alteration of motion segment integrity.

Figure 15-3a Loss of Motion Segment Integrity, Translation



A line is drawn along the posterior bodies of the vertebrae below and above the motion segment in question on dynamic (flexion and extension), lateral roentgenograms of the spine. The distance between lines A and B and the distance between lines B and C at the level of the posteroinferior corner of the upper vertebral body are summed. A value greater than 2.5 mm in the thoracic spine, greater than 4.5 mm in the lumbar spine, and greater than 3.5 mm in the cervical spine qualifies as loss of structural integrity.

Motion of the individual spine segments cannot be determined by a physical examination but is evaluated with flexion and extension roentgenograms (see Figures 15-3a through 15-3c).[13,14] Loss of motion segment integrity is defined as an anteroposterior motion of one vertebra over another that is greater than 3.5 mm in the cervical spine, greater than 2.5 mm in the thoracic spine, and greater than 4.5 mm in the lumbar spine (Figure 15-3a). Loss of motion segment integrity is also defined as a difference in the angular motion of two adjacent motion segments greater than 15° at L1-2, L2-3, and L3-4 and greater than 20° at L4 to L5. Loss of integrity of the lumbosacral joint is defined as angular motion between L5 and S1 that is greater than 25°. In the cervical spine, loss of motion segment integrity is defined as motion at the level in question that is more than 11° greater than at either adjacent level.

When routine x-rays are normal and severe trauma is absent, motion segment alteration is rare; thus, flexion and extension x-rays are indicated *only* when the physician suspects motion segment alteration from history or findings on routine x-rays.[14]

15.2 Determining the Appropriate Method for Assessment

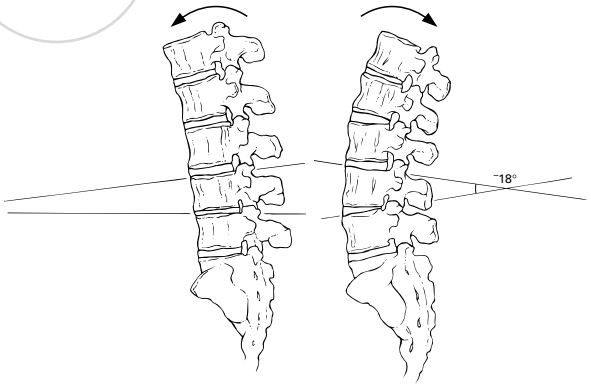
Spinal impairment rating is performed using one of two methods: the diagnosis-related estimate (DRE) or range-of-motion (ROM) method.

*The DRE method is the principal methodology used to evaluate an individual who has had a distinct injury.*When the cause of the impairment is not easily determined and if the impairment can be well characterized by the DRE method, the evaluator should use the DRE method.

The ROM method is used in several situations:

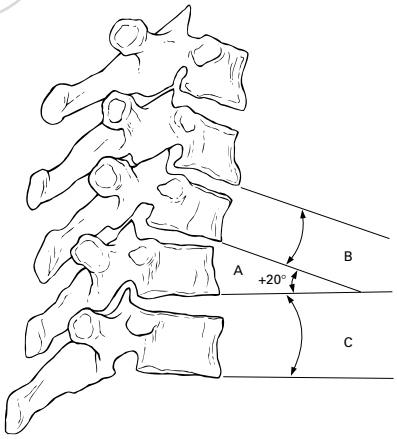
1. When an impairment is not caused by an injury, if the cause of the condition is uncertain and the DRE method does not apply, or an individual cannot be easily categorized in a DRE class. It is acknowledged that the cause of impairment (injury, illness, or aging) cannot always be determined. The reason for using the ROM method under these circumstances must be carefully supported in writing.

Figure 15-3b Loss of Motion Segment Integrity, Angular Motion (Sagittal Rotation), Lumbar Spine



Lines are drawn along the superior border of the vertebral body of the lower vertebrae and the superior border of the body of the upper vertebrae and the lines extended until they join. The angles are measured and subtracted. Note that lordosis (extension) is represented by a negative angle and kyphosis (flexion) by a positive angle. Loss of motion segment integrity is defined as motion greater than 15° at L1-2, L2-3, and L3-4 and greater than 20° at L4 to L5. Loss of integrity of the lumbosacral joint is defined as angular motion between L5 and S1 that is greater than 25°. The flexion angle is +8° and the extension angle is –18°. Therefore (+8) – (–18) = +26° and would qualify for loss of structural integrity at any lumbar level.

Figure 15-3c Loss of Motion Segment Integrity, Cervical Spine



Lines are drawn along the inferior borders of the two vertebral bodies adjacent to the level in question and of the vertebral bodies above and below those two vertebrae. Angles A, B, and C are measured on both flexion and extension x-rays and the measurements subtracted from one another. Note that lordosis (extension) is represented by a negative angle and kyphosis (flexion) is represented by a positive angle. Loss of motion segment integrity is defined as motion at the level in question that is more than 11° greater than at either adjacent level.

2. When there is multilevel involvement in the same spinal region (eg, fractures at multiple levels, disk herniations, or stenosis with radiculopathy at multiple levels or bilaterally).
3. Where there is alteration of motion segment integrity (eg, fusions) at multiple levels in the same spinal region, unless there is involvement of the corticospinal tract (then use the DRE method for corticospinal tract involvement).
4. Where there is recurrent radiculopathy caused by a new (recurrent) disk herniation or a recurrent injury in the same spinal region.
5. Where there are multiple episodes of other pathology producing alteration of motion segment integrity and/or radiculopathy.

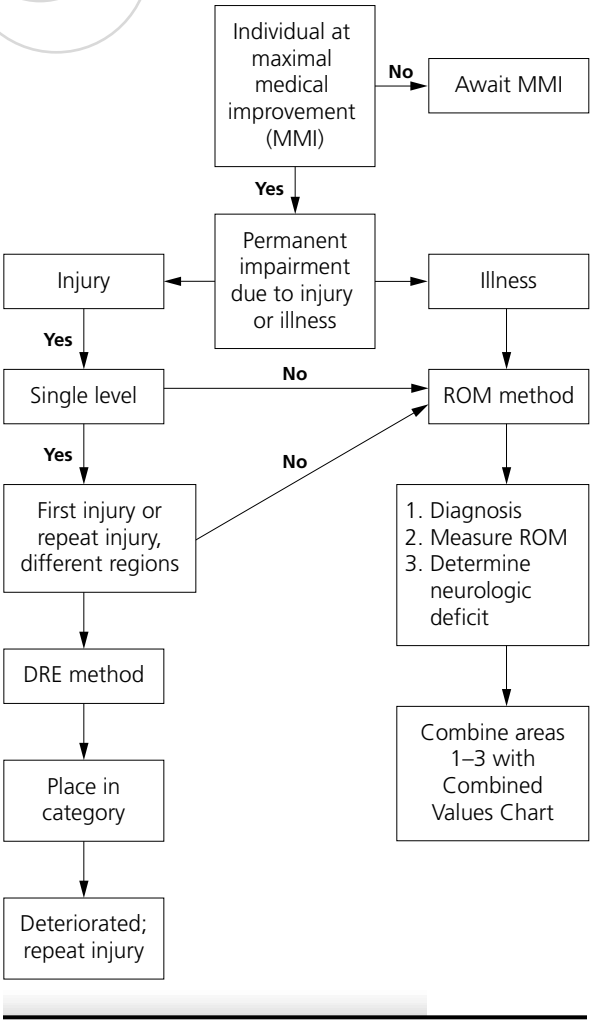
The ROM method can also be used if statutorily mandated in a particular jurisdiction.

In the small number of instances in which the ROM and DRE methods can both be used, evaluate the individual with both methods and award the higher rating.

All spine impairment ratings shown in Tables 15-3 to 15-5 estimate whole person impairment. With both the DRE method and the ROM method, whole person function is regarded as 100%. For converting whole person to regional spine impairments, see Section 15.13. When two or more regions are impaired and rated by either the DRE or ROM method, the ratings should be combined using the Combined Values Chart, p. 604.

A flowchart of the spine impairment evaluation process is provided in Figure 15-4.

Figure 15-4 Spine Impairment Evaluation Process



15.2a Summary of Specific Procedures and Directions

1. Take a careful history, perform a thorough medical examination, and review all pertinent records and studies. This is helpful in determining the presence or absence of structural abnormalities, nerve root or cord involvement, and motion segment integrity.
2. Consider the permanency of the impairment, referring to *Guides* Chapter 1 and the Glossary for definitions as needed. If the impairment is resolving, changing, unstable, or expected to change significantly with or without medical treatment within 12 months, it is not considered a permanent (stable) impairment and should not be rated under the *Guides* criteria.
3. Select the region that is primarily involved (ie, the lumbar, cervical, or thoracic spine) and identify the individual's most serious objective findings.
4. Determine whether the individual has multilevel involvement or multiple recurrences/occasions within the same region of the spine. Use the ROM method if:
   a. there are fractures at more than one level in a spinal region,
   b. there is radiculopathy bilaterally or at multiple levels in the same spinal region,
   c. there is multilevel motion segment alteration (such as a multilevel fusion) in the same spinal region, or
   d. there is recurrent disk herniation or stenosis with radiculopathy at the same or a different level in the same spinal region; in this case, combine the ratings using the ROM method.

5. If the individual does not have multilevel involvement or multiple recurrences/occasions and an injury occurred, determine the proper DRE category. Most ratings will fall into categories I, II, or III. A corticospinal tract injury is evaluated according to Section 15.7.
6. If the individual has been treated with surgery or another modality, evaluate the results, extent of improvement, and impact on the ability to perform activities of daily living. If residual symptoms or objective findings impact the ability to perform ADL despite treatment, the higher percentage in each range should be assigned. If an individual had a prior condition, was asymptomatic, and now—at MMI—has symptoms that impact the ability to perform activities of daily living, the higher rating within a range may also be used. If ratings are increased, explicit documentation of the reasons for the increase should be included in the report.
7. If more than one spine region is impaired, determine the impairment of the other region(s) with the DRE method. Combine the regional impairments using the Combined Values Chart (p. 604) to express the individual's total spine impairment.
8. From historical information and previously compiled medical data, determine if there was a preexisting impairment. Congenital, developmental, and other preexisting conditions may be differentiated from those attributable to the injury or illness by examining preinjury roentgenograms or by performing a bone scan after the onset of the condition.
9. If requested, apportion findings to the current or prior condition, following jurisdiction practices and assuming adequate information is available on the prior condition. In some instances, to apportion ratings, the percent impairment due to previous findings can simply be subtracted from the percent based on the current findings. Ideally, use the same method to compare the individual's prior and present conditions. If the ROM method has been used previously, it must be used again. If the previous evaluation was based on the DRE method and the individual now is evaluated with the ROM method, and prior ROM measurements do not exist to calculate a ROM impairment rating, the previous DRE percent can be subtracted from the ROM ratings. Because there are two methods and complete data may not exist on an earlier assessment, the apportionment calculation may be a less than ideal estimate.
10. For individuals with corticospinal tract involvement, refer to Table 15-6 for the appropriate impairment rating.

15.3 Diagnosis-Related Estimates Method

The DRE method has eight diagnosis-related categories for each of the three spinal regions. In assigning the individual to the correct DRE category, one of two approaches is used. The first is based on symptoms, signs, and appropriate diagnostic test results. The second is based on the presence of fractures and/or dislocations with or without clinical symptoms. If a fracture is present that places the individual into a DRE category, no other verification is required. The symptoms, signs other than fractures, and tests used to assist correct categorization of an individual are defined in Box 15-1.

Box 15-1 Definitions of Clinical Findings Used to Place an Individual in a DRE Category

Muscle Spasm
Muscle spasm is a sudden, involuntary contraction of a muscle or group of muscles. Paravertebral muscle spasm is common after acute spinal injury but is rare in chronic back pain. It is occasionally visible as a contracted paraspinal muscle but is more often diagnosed by palpation (a hard muscle). To differentiate true muscle spasm from voluntary muscle contraction, the individual should not be able to relax the contractions. The spasm should be present standing as well as in the supine position and frequently causes a scoliosis. The physician can sometimes differentiate spasm from voluntary contraction by asking the individual to place all his or her weight first on one foot and then the other while the physician gently palpates the paraspinous muscles. With this maneuver, the individual normally relaxes the paraspinal muscles on the weight-bearing side. If the examiner witnesses this relaxation, it usually means that true muscle spasm is not present.

Muscle Guarding
Guarding is a contraction of muscle to minimize motion or agitation of the injured or diseased tissue. It is not true muscle spasm because the contraction can be relaxed. In the lumbar spine, the contraction frequently results in loss of the normal lumbar lordosis, and it may be associated with reproducible loss of spinal motion.

Asymmetry of Spinal Motion
Asymmetric motion of the spine in one of the three principal planes is sometimes caused by muscle spasm or guarding. That is, if an individual attempts to flex the spine, he or she is unable to do so moving symmetrically; rather, the head or trunk leans to one side. To qualify as true asymmetric motion, the finding must be reproducible and consistent and the examiner must be convinced that the individual is cooperative and giving full effort.

Nonverifiable Radicular Root Pain
Nonverifiable pain is pain that is in the distribution of a nerve root but has no identifiable origin; ie, there are no objective physical, imaging, or electromyographic findings. For dermatomal distributions, see Figures 15-1 and 15-2.

Reflexes
Reflexes may be normal, increased, reduced, or absent. For reflex abnormalities to be considered valid, the involved and normal limb(s) should show marked asymmetry between arms or legs on repeated testing. Once lost because of previous radiculopathy, a reflex rarely returns. Abnormal reflexes such as Babinski signs or clonus may be signs of corticospinal tract involvement.

Weakness and Loss of Sensation
To be valid, the sensory findings must be in a strict anatomic distribution, ie, follow dermatomal patterns (see Figures 15-1 and 15-2). Motor findings should also be consistent with the affected nerve structure(s). Significant, long-standing weakness is usually accompanied by atrophy.

Atrophy
Atrophy is measured with a tape measure at identical levels on both limbs. For reasons of reproducibility, the difference in circumference should be 2 cm or greater in the thigh and 1 cm or greater in the arm, forearm, or leg. The evaluator can address asymmetry due to extremity dominance in the report.

Radiculopathy
Radiculopathy for the purposes of the *Guides* is defined as significant alteration in the function of a nerve root or nerve roots and is usually caused by pressure on one or several nerve roots. The diagnosis requires a dermatomal distribution of pain, numbness, and/or paresthesias in a dermatomal distribution. A root tension sign is usually positive. The diagnosis of herniated disk must be substantiated by an appropriate finding on an imaging study. The presence of findings on an imaging study in and of itself does not make the diagnosis of radiculopathy. There must also be clinical evidence as described above.

Electrodiagnostic Verification of Radiculopathy
Unequivocal electrodiagnostic evidence of acute nerve root pathology includes the presence of multiple positive sharp waves or fibrillation potentials in muscles innervated by one nerve root. However, the quality of the person performing and interpreting the study is critical. Electromyography should

be performed only by a licensed physician qualified by reason of education, training, and experience in these procedures. Electromyography does not detect all compressive radiculopathies and cannot determine the cause of the nerve root pathology. On the other hand, electromyography can detect noncompressive radiculopathies, which are not identified by imaging studies.

Alteration of Motion Segment Integrity
Motion segment alteration can be either loss of motion segment integrity (increased translational or angular motion) or decreased motion secondary to developmental fusion, fracture healing, healed infection, or surgical arthrodesis. An attempt at arthrodesis may not necessarily result in a solid fusion but may significantly limit motion at a motion segment. Motion of the individual spine segments cannot be determined by a physical examination but is evaluated with flexion and extension roentgenograms. The loss of motion segment integrity is defined in Section 15.1b.

Cauda Equina Syndrome
Cauda equina syndrome is manifested by bowel or bladder dysfunction, saddle anesthesia, and variable loss of motor and sensory function in the lower extremities. Individuals with cauda equina syndrome usually have loss of sphincter tone on rectal examination and diminished or absent bladder, bowel, and lower limb reflexes.

Urodynamic Tests
Cystometrograms are useful in individuals where a cauda equina syndrome is possible but not certain. A normal cystometrogram makes the presence of a nerve-related bladder dysfunction unlikely. Occasionally, more extensive urodynamic testing is necessary.

To use the DRE method, obtain an individual's history, examine the individual, review the results of appropriate diagnostic studies, and place the individual in the appropriate category. Although there are eight categories, almost all individuals will fall into one of the first three DRE categories. Altered motion segment integrity (ie, increased motion or loss of motion) qualifies the individual for category IV or V. A fracture and/or dislocation, with or without clinical symptoms, permits placement of the individual into a DRE category with no additional verification. If there are impairments in different spinal regions, rate each spinal region separately using the DRE method; then combine the ratings using the Combined Values Chart on page 604. As stated previously, fractures at more than one level in the same spinal region should be rated using the ROM method.

In most cases, using the definitions provided in Box 15-1, the physician can assign an individual to DRE category I, II, or III. An individual in category I has only subjective findings. In category II, the individual has objective findings but no radiculopathy or alteration of structural integrity, while in category III, radiculopathy with objective verification must be present. Since an individual is evaluated after having reached MMI, a previous history of objective findings may not define the current, ratable condition but is important in determining the course and whether MMI has been reached. *The impairment rating is based on the condition once MMI is reached, not on prior symptoms or signs.*

If the individual had a radiculopathy caused by a herniated disk or lateral spinal stenosis that responded to conservative treatment and currently has no radicular symptoms or signs, he or she is placed in category II, since at MMI there is no radiculopathy. Category III is for individuals with a symptomatic radiculopathy, either after medical or surgical treatment, or for individuals who have a history of previous radiculopathy caused by disk herniation or lateral spinal stenosis but have improved or become asymptomatic following surgery.

The DRE method recommends that physicians document physiologic and structural impairments relating to injuries or diseases other than common developmental findings, such as (1) spondylolysis, found normally in 7% of adults; (2) spondylolisthesis, found in 3% of adults; (3) herniated disk without radiculopathy, found in approximately 30% of individuals by age 40 years; and (4) aging changes, present in 40% of adults after age 35 years and in almost all individuals after age 50.[6,12] As previously noted, the presence of these abnormalities on imaging studies does not necessarily mean the individual has an impairment due to an injury.

In cases where the abnormalities discussed above are present on imaging studies and are known or assumed to have preexisted an injury being rated, physicians should acknowledge these antecedent conditions. If requested, physicians may need to assess whether the condition was previously symptomatic and whether any aggravation occurred as a result of the injury. Physicians should be aware of the statutory definition in the involved jurisdiction pertaining to *aggravation* to ensure their use of the term is consistent with their state's legal interpretation.

DRE categories are discussed in the following three sections.

15.4 DRE: Lumbar Spine

The lumbar spine DRE categories are summarized in Table 15-3. Apart from category I, each category includes a range to account for the resolution or continuation of symptoms and their impact on the ability to perform ADL.

Table 15-3 Criteria for Rating Impairment Due to Lumbar Spine Injury

DRE Lumbar Category I 0% Impairment of the Whole Person	DRE Lumbar Category II 5%- 8% Impairment of the Whole Person	DRE Lumbar Category III 10%-13% Impairment of the Whole Person	DRE Lumbar Category IV 20%-23% Impairment of the Whole Person	DRE Lumbar Category V 25%-28% Impairment of the Whole Person
No significant clinical findings, no observed muscle guarding or spasm, no documentable neurologic impairment, no documented alteration in structural integrity, and no other indication of impairment related to injury or illness; no fractures	Clinical history and examination findings are compatible with a specific injury; findings may include significant muscle guarding or spasm observed at the time of the examination, asymmetric loss of range of motion, or nonverifiable radicular complaints, defined as complaints of radicular pain without objective findings; no alteration of the structural integrity and no significant radiculopathy ***or*** individual had a clinically significant radiculopathy and has an imaging study that demonstrates a herniated disk at the level and on the side that would be expected based on the previous radiculopathy, but no longer has the radiculopathy following conservative treatment ***or*** fractures: (1) less than 25% compression of one vertebral body; (2) posterior element fracture without dislocation (not developmental spondylolysis) that has healed without alteration of motion segment integrity; (3) a spinous or transverse process fracture with displacement without a vertebral body fracture, which does not disrupt the spinal canal	Significant signs of radiculopathy, such as dermatomal pain and/or in a dermatomal distribution, sensory loss, loss of relevant reflex(es), loss of muscle strength or measured unilateral atrophy above or below the knee compared to measurements on the contralateral side at the same location; impairment may be verified by electrodiagnostic findings ***or*** history of a herniated disk at the level and on the side that would be expected from objective clinical findings, associated with radiculopathy, or individuals who had surgery for radiculopathy but are now asymptomatic ***or*** fractures: (1) 25% to 50% compression of one vertebral body; (2) posterior element fracture with displacement disrupting the spinal canal; in both cases, the fracture has healed without alteration of structural integrity	Loss of motion segment integrity defined from flexion and extension radiographs as at least 4.5 mm of translation of one vertebra on another or angular motion greater than 15° at L1-2, L2-3, and L3-4, greater than 20° at L4-5, and greater than 25° at L5-S1 (Figure 15-3); may have complete or near complete loss of motion of a motion segment due to developmental fusion, or successful or unsuccessful attempt at surgical arthrodesis ***or*** fractures: (1) greater than 50% compression of one vertebral body without residual neurologic compromise	Meets the criteria of DRE lumbosacral categories III and IV; that is, both radiculopathy and alteration of motion segment integrity are present; significant lower extremity impairment is present as indicated by atrophy or loss of reflex(es), pain, and/or sensory changes within an anatomic distribution (dermatomal), or electromyographic findings as stated in lumbosacral category III and alteration of spine motion segment integrity as defined in lumbosacral category IV ***or*** fractures: (1) greater than 50% compression of one vertebral body with unilateral neurologic compromise

DRE Lumbar Category I 0% Impairment of the Whole Person
No significant clinical findings, no observed muscle guarding or spasm, no documentable neurologic impairment, no documented alteration in structural integrity, and no other indication of impairment related to injury or illness; no fractures

Example 15-1
0% Impairment Due to Lumbar Injury

Subject: 24-year-old man.

History: Hurt his back while lifting a large, heavy box; described the pain as being in the lumbosacral region. Examination shortly after the injury was normal, except for a slight decrease in lumbar motion due to pain. No muscle spasm or weakness. The individual was treated with an analgesic. He was off work for 3 days and then returned and has continued to work.

Current Symptoms: Occasional soreness in the low back with heavy lifting; denies leg pain or numbness.

Physical Exam: No positive finding was present, including a negative SLR, normal strength, range of motion, and normal neurologic examination. No atrophy.

Clinical Studies: None.

Diagnosis: Minor lumbar strain.

Impairment Rating: 0% impairment of the whole person.

Comment: Since there are no objective findings at the time of the impairment evaluation, the individual is assigned to lumbar DRE category I.

DRE Lumbar Category II 5%- 8% Impairment of the Whole Person
Clinical history and examination findings are compatible with a specific injury; findings may include significant muscle guarding or spasm observed at the time of the examination, asymmetric loss of range of motion, or nonverifiable radicular complaints, defined as complaints of radicular pain without objective findings; no alteration of the structural integrity and no significant radiculopathy ***or*** individual had a clinically significant radiculopathy and has an imaging study that demonstrates a herniated disk at the level and on the side that would be expected based on the previous radiculopathy, but no longer has the radiculopathy following conservative treatment ***or*** fractures: (1) less than 25% compression of one vertebral body; (2) posterior element fracture without dislocation (not developmental spondylolysis) that has healed without alteration of motion segment integrity; (3) a spinous or transverse process fracture with displacement without a vertebral body fracture, which does not disrupt the spinal canal

Example 15-2
5% to 8% Impairment Due to Lumbar Injury

Subject: 25-year-old man.

History: Onset of low back and left thigh pain while lifting on the job. Examination revealed muscle spasm, a positive SLR on the left at 60°, a positive crossed SLR at 70°, and an absent left Achilles tendon reflex. Treated with physical therapy, improved, and returned to work after 6 weeks.

Current Symptoms: No pain at rest or numbness in the lower extremities 1 year after onset. Able to perform all ADL; some back pain with heavy activity.

Physical Exam: Full range of motion of the lumbar spine. SLR: negative. Motor and sensory functions are normal.

Clinical Studies: MRI: left posterolateral disk herniation L5-S1.

Diagnosis: Left posterolateral disk herniation L5-S1 with left S1 radiculopathy, resolved.

Impairment Rating: 5% impairment of the whole person.

Comment: This individual had a radiographically confirmed herniated disk, at the level and side expected from the physical examination. Most symptoms resolved with conservative treatment. At the time of evaluation, the individual was doing well, with no evidence of residual radiculopathy.

DRE Lumbar Category III 10%-13% Impairment of the Whole Person
Significant signs of radiculopathy, such as dermatomal pain and/or in a dermatomal distribution, sensory loss, loss of relevant reflex(es), loss of muscle strength or measured unilateral atrophy above or below the knee compared to measurements on the contralateral side at the same location; impairment may be verified by electrodiagnostic findings
or
history of a herniated disk at the level and on the side that would be expected from objective clinical findings, associated with radiculopathy, or individuals who had surgery for radiculopathy but are now asymptomatic
or
fractures: (1) 25% to 50% compression of one vertebral body; (2) posterior element fracture with displacement disrupting the spinal canal; in both cases, the fracture has healed without alteration of structural integrity

Example 15-3
10% to 13% Impairment Due to Surgically Treated Herniated Disk

Subject: 25-year-old man.

History: Onset of back and left posterior thigh and leg pain while twisting in a flexed position when lifting a moderately heavy package. Initially presented with muscle spasm, a positive SLR on the side at 60°, a positive crossed SLR at 70°, and an absent left Achilles tendon reflex. Treatment with physical therapy did not produce significant improvement. Underwent surgical diskectomy 3 months after the injury. Improved and returned to work without restrictions after 4 months of rehabilitation.

Current Symptoms: No pain at rest or numbness in the lower extremities 8 months after injury. Able to do most ADL but complains of back pain with heavy activity.

Physical Exam: Full range of motion of the lumbar spine. Loss of the Achilles reflex but normal motor and sensory functions. SLR: negative.

Clinical Studies: Original MRI: herniated disk at L5-S1. No additional studies have been done.

Diagnosis: Left posterolateral herniated disk at L5-S1 with left S1 radiculopathy, partially resolved status postdiskectomy.

Impairment Rating: 10% impairment of the whole person.

Comment: Symptoms, physical findings, and imaging studies are all consistent with a symptomatic herniated disk. Most symptoms and signs resolved with surgical treatment.

Example 15-4
10% to 13% Impairment Due to Radiculopathy

Subject: 25-year-old man.

History: New onset of back and left leg pain while lifting on the job. Initially presented with muscle spasm, a positive SLR on the left side at 60°, a positive crossed SLR at 70°, and an absent left Achilles tendon reflex. An MRI revealed a left posterolateral disk herniation at L5-S1. Was treated with analgesics and physical therapy but did not improve. Underwent surgical diskectomy 3 months after the injury. Some improvement in the symptoms after 9 months of rehabilitation.

Current Symptoms: Persistent back and thigh pain and numbness along the lateral side of the foot at rest. Unable to do his usual recreational and some household activities.

Physical Exam: Restricted lumbar motion. Loss of the Achilles reflex, numbness in the S1 nerve root distribution, and pain in the posterior thigh and leg on SLR.

Clinical Studies: Original MRI: herniated disk at L5-S1. Postoperative MRI with gadolinium: fibrosis but no residual or recurrent herniation.

Diagnosis: Chronic low back pain and radiculopathy.

Impairment Rating: 13% impairment of the whole person.

Comment: Symptoms, physical findings, and imaging studies are all consistent with a symptomatic herniated disk. Symptoms did not completely resolve after surgical treatment, with subjective and objective signs of persistent radiculopathy. Individual therefore qualifies for DRE lumbar category III. Because of significant persistent symptoms that limit the ability to perform ADL and continued objective findings, the impairment rating is increased to 13%.

DRE Lumbar Category IV
20%-23% Impairment of the Whole Person

Loss of motion segment integrity defined from flexion and extension radiographs as at least 4.5 mm of translation of one vertebra on another or angular motion greater than 15° at L1-2, L2-3, and L3-4, greater than 20° at L4-5, and greater than 25° at L5-S1 (Figure 15-3); may have complete or near complete loss of motion of a motion segment due to developmental fusion, or successful or unsuccessful attempt at surgical arthrodesis

or

fractures: (1) greater than 50% compression of one vertebral body without residual neurologic compromise

DRE Lumbar Category V
25%-28% Impairment of the Whole Person

Meets the criteria of DRE lumbosacral categories III and IV; that is, both radiculopathy and alteration of motion segment integrity are present; significant lower extremity impairment is present as indicated by atrophy or loss of reflex(es), pain, and/or sensory changes within an anatomic distribution (dermatomal), or electromyographic findings as stated in lumbosacral category III and alteration of spine motion segment integrity as defined in lumbosacral category IV

or

fractures: (1) greater than 50% compression of one vertebral body with unilateral neurologic compromise

Example 15-5
20% to 23% Impairment Due to Fracture With Greater Than 50% Compression of Vertebrae

Subject: 54-year-old woman.

History: Fell from a ladder and sustained a burst fracture of L2 with a 55% loss of height, without neurologic findings. Treated with bracing, the fracture healed; returned to most ADL 6 months after the injury.

Current Symptoms: No neurologic complaints, but has back pain after heavy activity or with weather changes.

Physical Exam: Mild tenderness to palpation at the fracture site. Neurologic examination and SLR: negative. Range of motion is mildly decreased.

Clinical Studies: Radiograph: fracture healed with 60% loss of height.

Diagnosis: Burst fracture L2 > 50%.

Impairment Rating: 20% impairment of the whole person.

Comment: Individual qualifies for lumbar DRE category IV based on the fracture. Neurologic deficit, if present, would warrant category V or Section 15.7. If she had multiple compression fractures in the same or different spinal regions, use the ROM method for rating.

Example 15-6
25% to 28% Impairment Due to Radiculopathy and Alteration of Motion Segment Integrity

Subject: 25-year-old man.

History: Onset of back and left leg pain after a fall on a concrete surface while carrying a box. Initially presented with muscle spasm, an SLR on the left side at 60°, a positive crossed SLR at 70°, and an absent left Achilles tendon reflex. Treated with physical therapy but did not improve. Underwent surgical diskectomy and arthrodesis of L5-S1 3 months after the injury. After 9 months of rehabilitation, leg and back symptoms were diminished but persistent.

Current Symptoms: Back and thigh pain at rest and persistent numbness along the lateral side of the foot 1 year after the onset of symptoms. Pain and numbness prevent individual from maintaining a constant position, prolonged standing or walking, or performing his prior work, recreational, and some household activities.

Physical Exam: Severely restricted range of motion. Loss of the Achilles reflex. Numbness in the S1 nerve root distribution and dermatomal pain in the leg on SLR.

Clinical Studies: Original MRI: a severely degenerated L5-S1 disk with a herniation on the left side. Postoperative MRI with gadolinium: fibrosis, but no residual or recurrent herniation. Fusion appears solid.

Diagnosis: Left posterolateral disk herniation L5-S1 with S1 radiculopathy and severe disk degeneration, unresolved status postdiskectomy and L5-S1 fusion.

Impairment Rating: 28% impairment of the whole person.

Comment: Symptoms, physical findings, and imaging studies are all consistent with a symptomatic herniated disk. Excision of the offending disk and a single-level fusion did not relieve all symptoms, which are supported by signs of a persistent radiculopathy. Individual qualifies for lumbar DRE category V because he has persistent radiculopathy as well as single-level alteration of motion segment integrity.

15.5 DRE: Thoracic Spine

Thoracic problems are evaluated as follows:

For thoracic spine problems localized to the thoracic region, use Table 15-4. If the thoracic pathology also leads to isolated bowel or bladder dysfunction not due to corticospinal damage, obtain the appropriate estimates for bowel and bladder dysfunction listed in the gastrointestional and urology chapters and combine these with the thoracic spine DRE category (I-V) listed in Table 15-4. If the thoracic spine problem is due to corticospinal tract involvement, use Section 15.7. If thoracic injury–related bowel or bladder symptoms exist without verifiable lower extremity involvement, then appropriate estimates for bowel and bladder impairments from the *Guides* chapters on the urinary and reproductive and digestive systems should be combined (Combined Values Chart, p. 604) with an impairment percent from one of the thoracic categories II through V.

The thoracic spine impairment DRE categories are summarized in Table 15-4.

Table 15-4 Criteria for Rating Impairment Due to Thoracic Spine Injury

DRE Thoracic Category I 0% Impairment of the Whole Person	DRE Thoracic Category II 5%-8% Impairment of the Whole Person	DRE Thoracic Category III 15%-18% Impairment of the Whole Person	DRE Thoracic Category IV 20%-23% Impairment of the Whole Person	DRE Thoracic Category V 25%-28% Impairment of the Whole Person
No significant clinical findings, no observed muscle guarding, no documentable neurologic impairment, no documented changes in structural integrity, and no other indication of impairment related to injury or illness; no fractures	History and examination findings are compatible with a specific injury or illness; findings may include significant muscle guarding or spasm observed at the time of the examination, asymmetric loss of range of motion (dysmetria), or nonverifiable radicular complaints, defined as complaints of radicular pain without objective findings; no alteration of motion segment integrity ***or*** herniated disk at the level and on the side that would be expected from objective clinical findings, but without radicular signs following conservative treatment ***or*** fractures: (1) less than 25% compression of one vertebral body; (2) posterior element fracture without dislocation that has healed without alteration of motion segment integrity or radiculopathy; (3) a spinous or transverse process fracture with displacement, but without a vertebral body fracture	Ongoing neurologic impairment of the lower extremity related to a thoracolumbar injury, documented by examination of motor and sensory functions, reflexes, or findings of unilateral atrophy above or below the knee related to no other condition; impairment may be verified by electrodiagnostic testing ***or*** clinically significant radiculopathy, verified by an imaging study that demonstrates a herniated disk at the level and on the side that would be expected from objective clinical findings; history of radiculopathy, which has improved following surgical treatment ***or*** fractures: (1) 25% to 50% compression fracture of one vertebral body; (2) posterior element fracture with mild displacement disrupting the canal; in both cases the fracture has healed without alteration of structural integrity; differentiation from a congenital or developmental condition should be accomplished, if possible, by examining preinjury roentgenograms, if available, or by a bone scan performed after the onset of the condition	Alteration of motion segment integrity or bilateral or multilevel radiculopathy; alteration of motion segment integrity is defined from flexion and extension radiographs as translation of one vertebra on another of more than 2.5 mm; radiculopathy as defined in thoracic category III need not be present if there is alteration of motion segment integrity; if an individual is to be placed in DRE thoracic category IV due to radiculopathy, the latter must be bilateral or involve more than one level ***or*** fractures: (1) more than 50% compression of one vertebral body without residual neural compromise	Impairment of the lower extremity as defined in thoracolumbar category III and loss of structural integrity as defined in thoracic category IV ***or*** fractures: (1) greater than 50% compression of one vertebral body with neural motor compromise but not bilateral involvement that would qualify the individual for corticospinal tract evaluation

DRE Thoracic Category I 0% Impairment of the Whole Person
No significant clinical findings, no observed muscle guarding, no documentable neurologic impairment, no documented changes in structural integrity, and no other indication of impairment related to injury or illness; no fractures

Example 15-7
0% Impairment Due to Thoracic Injury

Subject: 44-year-old man.

History: Working from home spending many hours on the phone and computer.

Current Symptoms: Chronic, bilateral, upper back discomfort under the scapula area worsened 3 to 4 months ago, but unchanged since. Feels better when not working at the computer.

Physical Exam: Hunched posture. Minimal tenderness to deep palpation over the descending trapezius muscles and the periscapular area, right side more pronounced. Otherwise normal examination.

Clinical Studies: None.

Diagnosis: Upper back pain.

Impairment Rating: 0% impairment of the whole person.

Comment: The individual was educated concerning the importance of proper posture, an appropriate workstation, and the need for stretching and strengthening exercises to alleviate the temporary discomfort.

DRE Thoracic Category II **5%-8% Impairment of the Whole Person**
History and examination findings are compatible with a specific injury or illness; findings may include significant muscle guarding or spasm observed at the time of the examination, asymmetric loss of range of motion (dysmetria), or nonverifiable radicular complaints, defined as complaints of radicular pain without objective findings; no alteration of motion segment integrity
or
herniated disk at the level and on the side that would be expected from objective clinical findings, but without radicular signs following conservative treatment
or
fractures: (1) less than 25% compression of one vertebral body; (2) posterior element fracture without dislocation that has healed without alteration of motion segment integrity or radiculopathy; (3) a spinous or transverse process fracture with displacement, but without a vertebral body fracture

Example 15-8
5% to 8% Impairment Due to Thoracic Injury

Subject: 56-year-old man.

History: Laborer with prior history of multiple musculoskeletal injuries during college football, from which he had fully recovered. Developed severe right-sided, radiating arm pain with tingling along the chest and the underside of the right arm while moving a refrigerator. Most of the pain has disappeared, but individual still has some discomfort when lifting the right arm above shoulder level.

Current Symptoms: Persistent numbness along the medial right arm.

Physical Exam: Numbness along a T1-3 dermatomal area in chest, not clearly defined.

Clinical Studies: MRI: degenerative disk changes at T1-2. Radiographs: osteophyte T1, T2 levels.

Diagnosis: Degenerative disk disease T1.

Impairment Rating: 5% impairment of the whole person.

Comment: Impairment rating would increase by up to 3% if individual was unable to do ADL as indicated in Table 1-2.

DRE Thoracic Category III **15%-18% Impairment of the Whole Person**
Ongoing neurologic impairment of the lower extremity related to a thoracolumbar injury, documented by examination of motor and sensory functions, reflexes, or findings of unilateral atrophy above or below the knee related to no other condition; impairment may be verified by electrodiagnostic testing
or
clinically significant radiculopathy, verified by an imaging study that demonstrates a herniated disk at the level and on the side that would be expected from objective clinical findings; history of radiculopathy, which has improved following surgical treatment
or
fractures: (1) 25% to 50% compression fracture of one vertebral body; (2) posterior element fracture with mild displacement disrupting the canal; in both cases the fracture has healed without alteration of structural integrity; differentiation from a congenital or developmental condition should be accomplished, if possible, by examining preinjury roentgenograms, if available, or by a bone scan performed after the onset of the condition

Example 15-9
15% to 18% Impairment Due to Thoracic Injury

Subject: 35-year-old man.

History: Individual fell from the second floor of a building on which he was working and sustained a compression fracture of T8. After conservative treatment, able to perform most ADL and walk without braces or crutches.

Current Symptoms: Minor back pain with heavy physical activity. Left lower extremity weakness and numbness in the left leg.

Physical Exam: Spotty numbness in the left leg and grade 4/5 left leg weakness. Measurable atrophy of left thigh and leg. Left leg reflexes are slightly hypoactive.

Clinical Studies: Compression fracture of T8 with loss of height of the vertebral body of about 30%.

Diagnosis: Compression fracture T8 with residual left lower extremity neurologic involvement.

Impairment Rating: 15% impairment of the whole person.

Comment: This individual qualifies for DRE thoracic category III because of his ongoing neurologic deficits and structural inclusion of a compression fracture with 25% to 50% loss of height.

DRE Thoracic Category IV
20%-23% Impairment of the Whole Person

Alteration of motion segment integrity or bilateral or multilevel radiculopathy; alteration of motion segment integrity is defined from flexion and extension radiographs as translation of one vertebra on another of more than 2.5 mm; radiculopathy as defined in thoracic category III need not be present if there is alteration of motion segment integrity; if an individual is to be placed in DRE thoracic category IV due to radiculopathy, the latter must be bilateral or involve more than one level

or

fractures: (1) more than 50% compression of one vertebral body without residual neural compromise

Example 15-10
20% to 23% Impairment Due to Compression Fracture of T1

Subject: 56-year-old-man.

History: Truck driver in motor vehicle accident was unconscious and had a seizure. Improved with physical therapy. Able to drive again and do usual ADL. No further seizures; off medication.

Current Symptoms: Bilateral upper extremity heaviness and weakness.

Physical Exam: Numbness over T1 distribution bilaterally; weakness of the intrinsic hand muscles.

Clinical Studies: 65% compression fracture of T1.

Diagnosis: Compression fracture of T1 with bilateral radiculopathy. New onset seizure disorder.

Impairment Rating: 20% impairment due to musculoskeletal disorder; combine with appropriate rating due to the seizure disorder to determine whole person impairment (see Combined Values Chart, p. 604).

Comment: No additional impairment since he is doing well.

DRE Thoracic Category V
25%-28% Impairment of the Whole Person

Impairment of the lower extremity as defined in thoracolumbar category III and loss of structural integrity as defined in thoracic category IV

or

fractures: (1) greater than 50% compression of one vertebral body with neural motor compromise but not bilateral involvement that would qualify the individual for corticospinal tract evaluation

Example 15-11
25% to 28% Impairment Due to Radiculopathy and Alteration of Motion Segment Integrity

Subject: 35-year-old man.

History: Individual fell from the second floor of a building on which he was working and sustained a compression fracture of T8. He had minor right lower extremity weakness and numbness. After anterior surgical decompression and instrumented fusion from T7 through T9 he improved and was able to return to most ADL and walk without braces or crutches, but he still had weakness and patchy numbness in the right lower extremity.

Current Symptoms: Minor pain on heavy activity.

Physical Exam: Neurologically, spotty numbness in the right lower extremity with 4/5 weakness and mild atrophy of the right thigh and leg muscles. Right lower extremity reflexes are slightly hyperactive.

Clinical Studies: MRI: compression fracture T8 without canal compromise. Radiograph: treated fracture with fusion.

Diagnosis: Compression fracture T8 treated surgically with mild residual right lower extremity neurologic involvement.

Impairment Rating: 25% impairment of the whole person by DRE method; another option is to use the ROM method.

Comment: This individual qualifies for DRE thoracic category V because he has mild right lower extremity neurologic deficits (category III) and alteration of motion segment integrity given the fusion (category IV). A combination of categories III and IV in the thoracic region means that the individual qualifies for category V. Because he has alteration of motion segment integrity of more than one level (multilevel fusion), he could also be rated by the ROM method. The best approach would be to rate the individual by both methods and award the higher rating.

15.6 DRE: Cervical Spine

15.6a Criteria for Rating Impairment Due to Cervical Disorders

For cervical problems localized to the cervical or cervicothoracic region, use Table 15-5. If the cervical spine problem also leads to isolated bowel and/or bladder dysfunction not due to corticospinal damage, obtain the appropriate estimates for bowel and bladder dysfunction from the gastrointestinal and urology chapters (Chapters 6 and 7) and combine these with the appropriate cervical spine DRE category from DRE I to V, listed in Table 15-5. If the cervical spine problem is due to corticospinal tract involvement, use Table 15-6 alone.

The DRE cervical categories are summarized in Table 15-5.

Table 15-5 Criteria for Rating Impairment Due to Cervical Disorders

DRE Cervical Category I 0% Impairment of the Whole Person	DRE Cervical Category II 5%-8% Impairment of the Whole Person	DRE Cervical Category III 15%-18% Impairment of the Whole Person	DRE Cervical Category IV 25%-28% Impairment of the Whole Person	DRE Cervical Category V 35%-38% Impairment of the Whole Person
No significant clinical findings, no muscular guarding, no documentable neurologic impairment, no significant loss of motion segment integrity, and no other indication of impairment related to injury or illness; no fractures	Clinical history and examination findings are compatible with a specific injury; findings may include muscle guarding or spasm observed at the time of the examination by a physician, asymmetric loss of range of motion or nonverifiable radicular complaints, defined as complaints of radicular pain without objective findings; no alteration of the structural integrity ***or*** individual had clinically significant radiculopathy and an imaging study that demonstrated a herniated disk at the level and on the side that would be expected based on the radiculopathy, but has improved following nonoperative treatment ***or*** fractures: (1) less than 25% compression of one vertebral body; (2) posterior element fracture without dislocation that has healed without loss of structural integrity or radiculopathy; (3) a spinous or transverse process fracture with displacement	Significant signs of radiculopathy, such as pain and/or sensory loss in a dermatomal distribution, loss of relevant reflex(es), loss of muscle strength, or unilateral atrophy compared with the unaffected side, measured at the same distance above or below the elbow; the neurologic impairment may be verified by electrodiagnostic findings ***or*** individual had clinically significant radiculopathy, verified by an imaging study that demonstrates a herniated disk at the level and on the side expected from objective clinical findings with radiculopathy or with improvement of radiculopathy following surgery ***or*** fractures: (1) 25% to 50% compression of one vertebral body; (2) posterior element fracture with displacement disrupting the spinal canal; in both cases the fracture is healed without loss of structural integrity; radiculopathy may or may not be present; differentiation from congenital and developmental conditions may be accomplished, if possible, by examining preinjury roentgenograms or a bone scan performed after the onset of the condition	Alteration of motion segment integrity or bilateral or multilevel radiculopathy; alteration of motion segment integrity is defined from flexion and extension radiographs as at least 3.5 mm of translation of one vertebra on another, or angular motion of more than 11° greater than at each adjacent level (Figures 15-3a and 15-3b); alternatively, the individual may have loss of motion of a motion segment due to a developmental fusion or successful or unsuccessful attempt at surgical arthrodesis; radiculopathy as defined in cervical category III need not be present if there is alteration of motion segment integrity ***or*** fractures: (1) more than 50% compression of one vertebral body without residual neural compromise	Significant upper extremity impairment requiring the use of upper extremity external functional or adaptive device(s); there may be total neurologic loss at a single level or severe, multilevel neurologic dysfunction ***or*** fractures: structural compromise of the spinal canal is present with severe upper extremity motor and sensory deficits but without lower extremity involvement

DRE Cervical Category I 0% Impairment of the Whole Person
No significant clinical findings, no muscular guarding, no documentable neurologic impairment, no significant loss of motion segment integrity, and no other indication of impairment related to injury or illness; no fractures

Example 15-12
0% Impairment Due to Cervical Injury

Subject: 37-year-old man.

History: Complaints of neck discomfort when painting.

Current Symptoms: Intermittent neck pain, occasionally extending into upper back bilaterally, moreso on the left side.

Physical Exam: Full neck motion, but pain at the extremes; some tenderness over the trapezius muscles; no spasm; no neurologic findings.

Clinical Studies: Radiographs: normal cervical spine.

Diagnosis: Intermittent cervical neck strain.

Impairment Rating: 0% impairment of the whole person.

Comment: No evidence of permanent impairment, without objective signs. Advised to do appropriate stretching and neck exercises regularly, before and after vigorous activity.

DRE Cervical Category II 5%-8% Impairment of the Whole Person
Clinical history and examination findings are compatible with a specific injury; findings may include muscle guarding or spasm observed at the time of the examination by a physician, asymmetric loss of range of motion or nonverifiable radicular complaints, defined as complaints of radicular pain without objective findings; no alteration of the structural integrity ***or*** individual had clinically significant radiculopathy and an imaging study that demonstrated a herniated disk at the level and on the side that would be expected based on the radiculopathy, but has improved following nonoperative treatment ***or*** fractures: (1) less than 25% compression of one vertebral body; (2) posterior element fracture without dislocation that has healed without loss of structural integrity or radiculopathy; (3) a spinous or transverse process fracture with displacement

Example 15-13
5% to 8% Impairment Due to Cervical Injury

Subject: 37-year-old woman.

History: Pain in the neck and lateral right upper extremity extending to the thumb following a rear-end auto collision. An MRI showed a herniated disk at C6. She elected nonoperative treatment and recovered after 18 months.

Current Symptoms: Some residual neck pain with physical activity; upper limb symptoms have resolved.

Physical Exam: Slight loss of motion of the cervical spine. Neurologic examination is normal.

Clinical Studies: Initial MRI: right posterolateral disk herniation at C5. No additional imaging studies were done.

Diagnosis: Herniated disk C5-6 with resolved right C6 radiculopathy.

Impairment Rating: 5% impairment of the whole person.

Comment: The individual qualifies for DRE cervical category II because she had a radiculopathy caused by a herniated disk that responded to treatment. She has no significant residual signs.

DRE Cervical Category III
15%-18% Impairment of the Whole Person

Significant signs of radiculopathy, such as pain and/or sensory loss in a dermatomal distribution, loss of relevant reflex(es), loss of muscle strength, or unilateral atrophy compared with the unaffected side, measured at the same distance above or below the elbow; the neurologic impairment may be verified by electrodiagnostic findings

or

individual had clinically significant radiculopathy, verified by an imaging study that demonstrates a herniated disk at the level and on the side expected from objective clinical findings with radiculopathy or with improvement of radiculopathy following surgery

or

fractures: (1) 25% to 50% compression of one vertebral body; (2) posterior element fracture with displacement disrupting the spinal canal; in both cases the fracture is healed without loss of structural integrity; radiculopathy may or may not be present; differentiation from congenital and developmental conditions may be accomplished, if possible, by examining preinjury roentgenograms or by bone scans performed after the onset of the condition

Example 15-14
15% to 18% Impairment Due to Radiculopathy

Subject: 44-year-old man.

History: Sustained a blow to his posterior neck from a machine support that slipped. Unable to use his dominant left hand for ADL without considerable pain in neck, left upper back, and ulnar left upper limb. No discomfort in the lower extremities. Refuses surgery.

Current Symptoms: Neck pain, radiating to the ulnar hand with numbness of the ring and little fingers.

Physical Exam: Decreased range of motion in the neck with severe radiating pain to the left arm in a C6 distribution.

Clinical Studies: MRI: left posterolateral disk herniation C7-8.

Diagnosis: Radiculopathy due to disk herniation C6.

Impairment Rating: 18% impairment of the whole person.

Comment: Residual symptoms and functional limitations to perform ADL.

DRE Cervical Category IV
25%-28% Impairment of the Whole Person

Alteration of motion segment integrity or bilateral or multilevel radiculopathy; alteration of motion segment integrity is defined from flexion and extension radiographs as at least 3.5 mm of translation of one vertebra on another, or angular motion of more than 11° greater than at each adjacent level (Figures 15-3a and 15-3b); alternatively, the individual may have loss of motion of a motion segment due to a developmental fusion or successful or unsuccessful attempt at surgical arthrodesis; radiculopathy as defined in cervical category III need not be present if there is alteration of motion segment integrity

or

fractures: (1) more than 50% compression of one vertebral body without residual neural compromise

Example 15-15
25% to 28% Impairment Due to Alterations of Motion Segment Integrity

Subject: 37-year-old woman.

History: Onset of pain in the neck and right arm along the radial aspect and into the thumb following a medium-speed rear-end auto collision. Individual failed conservative treatment, and an MRI showed a herniated disk at C6-7. Underwent a diskectomy of the sixth cervical disk and fusion of C6 to C7. Healed uneventfully and returned to work 4 months after the injury.

Current Symptoms: Occasional neck pain with physical activity. Upper extremity pain resolved.

Physical Exam: Slight loss of cervical spine motion. Neurologic examination is normal.

Clinical Studies: Radiographs: healed C6-7 fusion.

Diagnosis: Herniated disk C6-7 with C7 radiculopathy resolved following anterior cervical diskectomy and C6-7 fusion.

Impairment Rating: 25% impairment of the whole person.

Comment: This individual meets criteria for DRE cervical category IV because of alteration of motion segment integrity due to fusion.

DRE Cervical Category V 35%-38% Impairment of the Whole Person
Significant upper extremity impairment requiring the use of upper extremity external functional or adaptive device(s); there may be total neurologic loss at a single level or severe, multilevel neurologic dysfunction ***or*** fractures: structural compromise of the spinal canal is present with severe upper extremity motor and sensory deficits but without lower extremity involvement

Example 15-16
35% to 38% Impairment Due to Herniated Cervical Disk Postdiskectomy and Fusion

Subject: 37-year-old woman.

History: Individual fell and struck her posterior head and neck on a conveyor machine while working on an assembly line. She had severe and persistent pain in the neck and lateral right upper limb extending into the thumb. An MRI showed a herniated disk at C5-6. She failed nonoperative treatment and underwent a diskectomy of the sixth cervical disk and fusion of C6 to C7. She has continued neck and bilateral upper extremity pain. Unable to perform most ADL and uses assistive devices for gripping and turning objects.

Current Symptoms: Severe neck and bilateral upper extremity pain aggravated by movements of the neck and use of the upper extremities. Persistent numbness in the radial forearm, hand, and digits on both sides.

Physical Exam: Slight loss of cervical motion. Neurologic examination reveals decreased sensation in the thumb and index finger and weakness of the biceps and wrist extensors bilaterally. Diminished brachioradialis reflexes, right worse than left.

Clinical Studies: Radiographs: healed fusion.

Diagnosis: Herniated C5-6 disk treated with residual bilateral C6 radiculopathy.

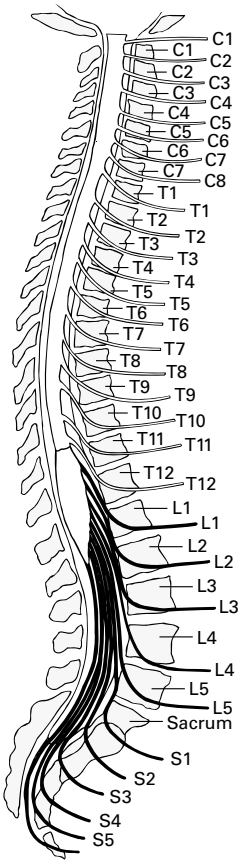
Impairment Rating: 38% impairment of the whole person.

Comment: This individual meets criteria for both DRE cervical category III, with a surgically treated radiculopathy, and DRE cervical category IV, because of alteration of motion segment integrity due to the fusion, and is placed in DRE category V because of objective findings supportive of significant upper extremity impairment requiring the use of adaptive devices.

15.7 Rating Corticospinal Tract Damage

The neurologic level of involvement is determined by identifying the level of cord involvement, not necessarily the same level as a fracture, because the root function at the fracture level frequently returns with time. The level of cord involvement is determined by identifying the lowest normally functioning nerve root. Identifying the level of nerve root function helps to determine the degree of residual function. Figure 15-5 illustrates the relationship of nerve roots to the vertebral level.

Figure 15-5 Relationship of Spinal Nerves to Vertebrae



The level at which nerve roots exit the spine relative to the vertebrae. The neurologic level of involvement is determined by identifying the lowest normally functioning nerve root.

Table 15-6 Rating Corticospinal Tract Impairment

a. Impairment of One Upper Extremity Due to Corticospinal Tract Impairment

Class 1		Class 2		Class 3		Class 4	
Dominant Extremity 1%-9% Impairment of the Whole Person	**Nondominant Extremity 1%-4% Impairment of the Whole Person**	**Dominant Extremity 10%-24% Impairment of the Whole Person**	**Nondominant Extremity 5%-14% Impairment of the Whole Person**	**Dominant Extremity 25%-39% Impairment of the Whole Person**	**Nondominant Extremity 15%-29% Impairment of the Whole Person**	**Dominant Extremity 40%-60% Impairment of the Whole Person**	**Nondominant Extremity 30%-45% Impairment of the Whole Person**
Individual can use the involved extremity for self-care, daily activities, and holding, but has difficulty with digital dexterity		Individual can use the involved extremity for self-care, can grasp and hold objects with difficulty, but has no digital dexterity		Individual can use the involved extremity but has difficulty with self-care activities		Individual cannot use the involved extremity for self-care or daily activities	

b. Criteria for Rating Impairments of Two Upper Extremities

Class 1 1%-19% Impairment of the Whole Person	Class 2 20%-39% Impairment of the Whole Person	Class 3 40%-79% Impairment of the Whole Person	Class 4 80%+ Impairment of the Whole Person
Individual can use both upper extremities for self-care, grasping, and holding, but has difficulty with digital dexterity	Individual can use both upper extremities for self-care, can grasp and hold objects with difficulty, but has no digital dexterity	Individual can use both upper extremities but has difficulty with self-care activities	Individual cannot use upper extremities

c. Criteria for Rating Impairments Due to Station and Gait Disorders

Class 1 1%-9% Impairment of the Whole Person	Class 2 10%-19% Impairment of the Whole Person	Class 3 20%-39% Impairment of the Whole Person	Class 4 40%-60% Impairment of the Whole Person
Rises to standing position; walks, but has difficulty with elevations, grades, stairs, deep chairs, and long distances	Rises to standing position; walks some distance with difficulty and without assistance, but is limited to level surfaces	Rises and maintains standing position with difficulty; cannot walk without assistance	Cannot stand without help, mechanical support, and/or an assistive device

In prior editions of the *Guides*, rating spinal cord injury was done either through a combination of DRE categories or in the nervous system chapter. It was decided in this edition to evaluate spinal cord injuries based on the criteria in the nervous system chapter (Chapter 13). These criteria are repeated in this section. For bilateral neurologic or corticospinal tract damage, consultation with a spinal cord injury specialist and review of Chapter 13, The Central and Peripheral Nervous System, is recommended. Thus, for an individual with a spinal cord injury affecting the upper extremities, use Table 15-6 and the appropriate impairment rating for impairment of one or both upper extremities. For impairments involving loss of use of the lower extremities, use the section in Table 15-6 pertaining to station and gait impairment. If there is additional bowel or bladder dysfunction, combine the upper extremity or lower extremity loss with impairments in bladder, anorectal, and/or neurologic sexual impairment as warranted.

Once a class has been selected, the exact value is obtained by combining the value with the corresponding additional impairment from DRE categories II through V for cervical and lumbar impairment and DRE categories II through IV for thoracic impairment. An exact value is determined based on the degree of impairment of ADL. Table 15-6 and the following examples illustrate the method for impairment rating of spinal cord injury.

Example 15-17
69% Impairment Due to Compression Fracture With Corticospinal Tract Damage

Subject: 28-year-old man.

History: Sustained a C6 vertebral body fracture with almost 40% compression after a fall from a scaffold. Had loss of bladder control and weakness of both lower extremities. He also had numbness and

d. Criteria for Rating Neurologic Impairment of the Bladder

Class 1 1%-9% Impairment of the Whole Person	Class 2 10%-24% Impairment of the Whole Person	Class 3 25%-39% Impairment of the Whole Person	Class 4 40%-60% Impairment of the Whole Person
Individual has some degree of voluntary control but is impaired by urgency or intermittent incontinence	Individual has good bladder reflex activity, limited capacity, and intermittent emptying without voluntary control	Individual has poor bladder reflex activity, intermittent dribbling, and no voluntary control	Individual has no reflex or voluntary control of bladder

e. Criteria for Rating Neurologic Anorectal Impairment

Class 1 1%-19% Impairment of the Whole Person	Class 2 20%-39% Impairment of the Whole Person	Class 3 40%-50% Impairment of the Whole Person
Individual has reflex regulation but only limited voluntary control	Individual has reflex regulation but no voluntary control	Individual has no reflex regulation or voluntary control

f. Criteria for Rating Neurologic Sexual Impairment

Class 1 1%-9% Impairment of the Whole Person	Class 2 10%-19% Impairment of the Whole Person	Class 3 20% Impairment of the Whole Person
Sexual functioning is possible, but with difficulty of erection or ejaculation in men or lack of awareness, excitement, or lubrication in either sex	Reflex sexual functioning is possible, but there is no awareness	No sexual functioning

g. Criteria for Rating Neurologic Impairment of Respiration

Class 1 5%-19% Impairment of the Whole Person	Class 2 20%-49% Impairment of the Whole Person	Class 3 50%-89% Impairment of the Whole Person	Class 4 90%+ Impairment of the Whole Person
Individual can breathe spontaneously but has difficulty performing activities of daily living that require exertion	Individual is capable of spontaneous respiration but is restricted to sitting, standing, or limited ambulation	Individual is capable of spontaneous respiration but to such a limited degree that he or she is confined to bed	Individual has no capacity for spontaneous respiration

weakness of both upper extremities, which was verified as a C7-level radiculopathy by positive sharp waves on the electromyogram in three arm muscles 4 weeks after the injury. Underwent corpectomy of C6 and a fusion from C5 to C7.

Current Symptoms: Pain free with numbness and weakness of upper extremities; no remaining bladder symptoms. Unable to walk without leg braces (orthoses).

Physical Exam: Mild sensory changes from C7 distally. C6-innervated muscles function normally, but he had weakness of muscles innervated by C7 and lower nerve roots.

Clinical Studies: Neurodiagnostic studies: see above; radiographs show a solid fusion from C5 through C7.

Diagnosis: C6 compression fracture with corticospinal tract damage.

Impairment Rating: 69% impairment of the whole person.

Comment: Although this man has a vertebral fracture, his corticospinal tract involvement indicates he should be rated using the neurology tables. His numbness, weakness, and difficulty with dexterity movements of both upper extremities warrant a 39% WPI. He is unable to walk without braces, indicating a class 3 WPI of 39%. He has no bowel or bladder dysfunction. His vertebral fracture results in a DRE III, or 15% impairment. Combining 39%, 39%, and 15% WPI using the Combined Values Chart results in a 69% WPI.

Example 15-18
78% Impairment Due to Burst Fracture With Cauda Equina Syndrome

Subject: 54-year-old woman.

History: Fell from a ladder and sustained a burst fracture of L2 with a loss of height of 35%. In addition to numbness and weakness of both lower extremities, she was unable to empty her bladder and required catheterization. Following anterior decompression of the cauda equina and fusion from L1 to L3, the fractures healed, and she regained partial function in the muscles innervated by the L2 and lower nerve roots.

Current Symptoms: Persistent weakness of both lower extremities requiring the use of ankle-foot orthoses. Walks using two crutches. Requires intermittent catheterization of her bladder. She has occasional bowel incontinence.

Physical Exam: Mild tenderness to palpation at the fracture site. Neurologic examination reveals weakness of L2 to S1 innervated muscle and numbness and atrophy of both lower extremities. Decreased rectal tone. Knee and ankle reflexes are absent.

Clinical Studies: Repeat x-rays of the region: solid fusion from L1 to L3.

Diagnosis: Burst fracture L2 with cauda equina syndrome.

Impairment Rating: 78% impairment of the whole person.

Comment: Her lower extremity weakness and use of orthoses and crutches indicate a class 3, or 39%, WPI. The bladder impairment, requiring intermittent catheterization, indicates a class 4, or 50%, WPI. Her rectal tone is deceased, with occasional bowel incontinence, indicating a class 2 anorectal impairment of 20%. The burst fracture receives a DRE lumbar category III rating of 10%. Combining 50%, 39%, 20%, and 10% results in a combined whole person impairment of 78%.

15.8 Range-of-Motion Method

Although called the range-of-motion method, this evaluation method actually consists of three elements that need to be assessed: (1) the range of motion of the impaired spine region; (2) accompanying diagnoses (Table 15-7); and (3) any spinal nerve deficit, which is described in this chapter and in Chapter 13 (The Central and Peripheral Nervous System). Mobility, diagnoses, and nerve root deficits all provide important clinical information about function of an individual's spine.[15-21] An impairment rating based on loss of motion is valid only if there is medical evidence of a documented injury or illness with a permanent anatomic and/or physiologic residual dysfunction. The whole person impairment rating is obtained by combining ratings from all three components, using the Combined Values Chart (p. 604).

All impairment estimates shown in the tables of this section are expressed as whole person impairments. Section 15.13 explains how to express a whole person spine impairment as a regional spine impairment. Tables 15-8 through 15-14 provide estimates for rating ankylosis and range of motion, while neurologic impairments are rated based on Tables 15-15 through 15-18. The data on standards and normal functioning described in this section are based on both medical studies and consensus judgments.[15,18-27]

As previously stated (Section 15.2) the ROM method should be used only (1) if the DRE method is not applicable (no verifiable injury); (2) if, after obtaining the history and performing the examination, the physician cannot place the individual within a multilevel DRE category; (3) if multilevel involvement and/or alteration of motion segment integrity has occurred in the same spinal region; (4) if there is recurrent radiculopathy caused by a new (recurrent) disk herniation or a recurrent injury in the same spinal region; (5) if there are multiple episodes of other pathology producing alteration of motion segment integrity and/or radiculopathy; or (6) if statutorily mandated by the involved jurisdiction.

Concerns have been raised by users of the *Guides* regarding perceived age- and gender-related variations in the normal population, which may bias impairments in favor of males or older individuals, both of whom are perceived to be less flexible and therefore may be judged "impaired" even under normal circumstances. Since preparation of the fourth edition, some scientific evidence has accumulated and several relevant articles have been identified.[27-45]

Regarding gender, the scientific evidence is inconsistent. The majority of studies actually show a nonsignificant trend toward greater motion for male normal individuals in each age group. The only movement showing any statistically significant gender difference is cervical extension, and then only in younger women. This finding is inconsistent among various studies, however, and the difference disappears with advancing age.[35,41]

There is a decrease in normal motion with advancing age, but the effect is not linear. Most studies examining a wide spectrum of age groups find greater alterations in mobility below 20 and above 60 years of age. Several studies suggest that lifestyle factors may influence flexibility far more than inherent factors, as the variability of overall motion between individuals increases with advancing years. However, the evidence is inconsistent, and the changes in normative data too small for the most relevant age groups 20 to 59, to warrant age adjustment in this edition of the *Guides*.

15.8a General ROM Method Measurement Principles

Impairment should be evaluated when the condition has stabilized after completion of all necessary medical, surgical, and rehabilitative treatment. This principle precludes rating an acute illness or injury. For example, if acute muscle spasm is present, this should be noted in the examiner's report; however, the mobility measurements would not be valid for estimating permanent impairment. Because the *Guides* only considers permanent impairment, rating should be deferred until after any acute exacerbation of the chronic condition has subsided, ie, when the individual is at MMI (see Chapter 1 and the Glossary).

Pain, fear of injury, disuse, or neuromuscular inhibition may limit mobility by diminishing the individual's effort, leading to inaccurately low and inconsistent measurements. *The physician should seek consistency when testing active motion, strength, and sensation. Tests with inconsistent results should be repeated. Results that remain inconsistent should be disregarded. When the physiologic measurements fail to match known pathology, they should be repeated and, if still inconsistent, disallowed until documented evidence is provided for the abnormalities noted on the physical examination.*

The reproducibility (precision) of an individual's performance is one (but not the sole) indicator of optimum effort. When measuring range of motion, the examiner should obtain at least three consecutive measurements and calculate the mean (average) of the three. Measurements should not change substantially with repeated efforts. If the average is less than 50°, three consecutive measurements must fall within 5° of the mean; if the average is greater than 50°, three consecutive measurements must fall within 10% of the mean. Motion testing may be repeated up to six times to obtain three consecutive measurements that meet these criteria. If after six measurements inconsistency persists, the spinal motions are considered invalid. The measurements and accompanying impairment estimates may then be disallowed, in part or in their entirety.

There are multiple potential *sources of error* in a quantitative physical examination.[17,20,21] The greatest source of error that occurs is due to test administrator inexperience or lack of knowledge. The evaluator should also ensure adequate warm-up movements have been performed.[16] When possible, the individual being evaluated should warm up prior to the ROM measurements: flexion and extension twice, left and right rotation twice, left and right lateral bending twice, and one additional flexion and extension. The warm-up movements do not need to be repeated before each subsequent test of motions of the same spinal region.

The physician also needs to ensure the anatomical landmarks are accurate, the body part is stabilized, the measurement device is properly stabilized on the spine, and appropriate instructions are provided to the individual.[17,20,21] If these principles are followed, errors due to examination technique, the measurement device itself, or normal human variability will be minimized.

15.8b Principles of Inclinometry and Spine Motion Measurement

Since spinal motion is compound, it is essential to measure simultaneously motion of both the upper and lower extremes of the spine region being examined. Because the small joints of the spine do not lend themselves readily to two-arm goniometric measurements and measuring a spine segment's mobility is confounded by motion above and below the assessed points, an inclinometer is the preferred device for obtaining accurate, reproducible measurements in a simple, practical, and inexpensive way. The subcutaneous bony structures that mark the upper and lower ends of the three spine regions can be palpated readily.

Inclinometers, also called angle finders or level indicators, are small angle-measuring devices traditionally used by carpenters, mechanics, and tradespeople. Recently, physicians, therapists, and veterinarians have used them to measure angles and ranges of motion in humans and animals. Inclinometers work like a plumb line, operating on the principle of gravity, which is a constant. An inclinometer used by a physician should be marked off in 2° increments or less and in good operating condition (Figure15-6). A mechanical inclinometer has a starting or 0° position indicated by a weighted needle or pendulum. A fluid level can cause errors in reading the meniscus. A fluid-filled inclinometer should allow rotation of its inclinometer face so any number on the face can be set as the initial position. Electronic inclinometers use gravity sensors to determine an angle from the vertical, and then perform internal calculations.[21]

Figure 15-6 Inclinometer

Features of a properly designed inclinometer for medical use include a dial large enough to allow easy reading of 2° increments but small enough to enable application on the spine and all joints of the body; features to enable repeated, accurate application and stabilization of the instrument on the body; and a dial that can both display the 0° gravity position and be set by the examiner to a 0° starting position when the body part cannot be placed in a 0° gravity or neutral position.

Box 15-2 offers a partial list of companies that produce or distribute inclinometers. The American Medical Association does not endorse or recommend any particular type or brand of inclinometer.

Box 15-2 Inclinometer Distributors

The following companies distribute inclinometers. To receive information about their products, *Guides* users should contact the company.

Acumar Technology
1314 SW 57th Ave
Portland, OR 97221
503 292-7137
www.acumar.com

ISOMED, Inc
975 SE Sandy Blvd
Portland, OR 97214
503 233-0051
503 233-5128 (fax)
www.isomedinc.com
isomedinc@heaven.com (e-mail)

McMaster Carr
600 County Line Rd
Elmhurst, IL 60126
630 834-9600
www.mcmaster.com

The Saunders Group, Inc
4250 Norex Dr
Chaska, MN 55318
612 944-1656; 800 654-8357 (toll-free)
www.thesaundersgroup.com

Techmaster
11855 SW Ridge Crest Dr
Beaverton, OR 97008
503 671-9317
503 671-0168 (fax)
techmaster@transport.com (e-mail)

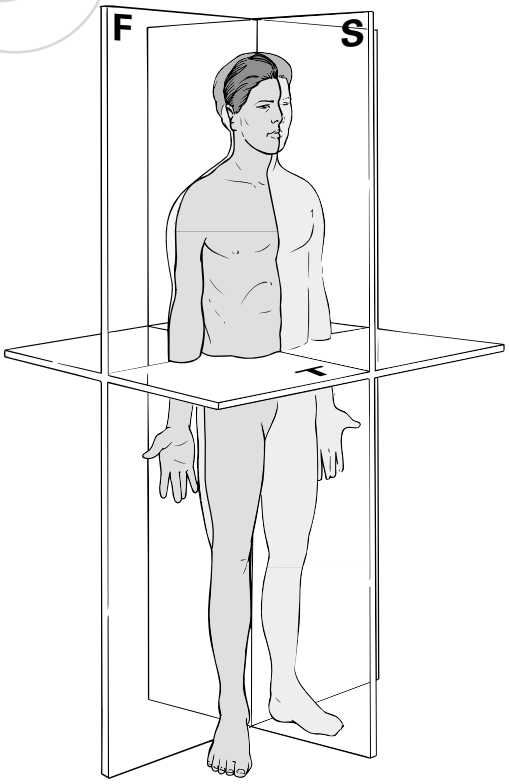
The following principles, discussed in greater detail by Mayer,[17] by Gerhardt et al,[20,21] and in forthcoming AMA educational material, are important to follow to obtain accurate measurements.

Gravitational plane. An inclinometer works only in the vertical position because only that plane allows the pointer or sensor to move freely in response to gravity. An inclinometer will not operate properly if tilted or at all when horizontal. Therefore, the individual being examined must be in a position that permits motion of the part being tested in a vertical plane. For spinal measurements in the sagittal and frontal (coronal) planes the individual should be standing or sitting, with the spine vertical (Figure 15-7). Measurements in the transverse or axial plane must be made with the individual in the supine, prone, or flexed hip position.

Measure spinal ROM in three principal planes: sagittal (extension-flexion), frontal or coronal, and transverse or axial (rotation) (Figure 15-7). If a spinal region has two or more impaired motions, the ratings for each range of motion impairment are *added*. Impairments of two or more regions of the spine are *combined* using the Combined Values Chart (p. 604).

Stabilization. If the caudad (superior), or lower, part of a spine region can be stabilized so it does not move when the superior, or upper, part moves, a single mechanical inclinometer may be used, as with measuring cervical rotation (see Figure 15-17). However, two inclinometers are usually needed to measure most movements of the spine. Single electronic inclinometers use microprocessors to duplicate functions of mechanical inclinometers. Their use will not be described in detail here as information is available from the manufacturer. The user should ensure that the features described above are addressed.

Figure 15-7 Body Planes for Measuring Motion



S: sagittal plane, **T:** transverse plane, **F:** frontal or coronal plane.

Manual pressure during use. The inclinometer should be held so it remains firmly applied to the subcutaneous skeletal structure while the spine is moving through the entire range of motion. It must not deviate from the original position because of skin movement or uneven pressure on the skin overlying the bony landmark, which might occur with an obese individual. The inclinometer design is important to allow proper application and avoid slippage on subcutaneous bony prominences. Firm contact of two points of the instrument with the structure is essential, especially if a convex surface such as the sacrum or calvarium (top of the head) is involved.

Recording ROM Measurements

ROM measurements can be recorded on the summary sheets (Figures 15-10, 15-15, and 15-18).

15.8c Ankylosis and Motion With Ankylosis

Ankylosis is defined as the complete absence of joint motion and is expressed as a fixed position. In the spine, which has multiple motion segments in each region with vertebrae moving together and separately, complete absence of regional motion is rare. For spine impairment evaluation only, when an individual cannot reach the neutral (0°) position, the position or angle of restriction closest to neutral is considered the position of ankylosis or end-restricted movement.

If the individual has end-restricted movement, this value, taken as the ankylosis value, is used to determine impairment instead of the ROM. If the motion crosses the neutral position in any plane, the examiner should use the abnormal motion section of the appropriate table to determine the impairment for that plane.

In determining ankylosis impairments, the examiner should *add* the ankylosis impairments in several planes within a single region or *combine* the ankylosis impairments of two or more regions (Combined Values Chart, p. 604). If a spinal region has several range-of-motion impairments and an ankylosis impairment, the ROM impairments are added and the total is combined with the ankylosis impairment. Impairments of two or more regions are always combined (Combined Values Chart).

15.8d Estimating Whole Person Impairment Using the ROM Method

1. Determine whether the individual has reached MMI and the impairment is stable. If the condition is changing or likely to improve substantially with medical treatment, the impairment is not permanent and should not be rated. If it is permanent, proceed to step 2.
2. Select the impaired region: cervical, thoracic, or lumbar.
3. Use Table 15-7 to determine the percentage impairment for the part of the ROM diagnosis–based method. If there are two or more diagnoses within a spinal region, use that which is most significant. This percent will be combined with those for the impaired range(s) of motion and the whole person neurologic deficit (steps 7-9 below).

4. Measure the range of motion in the relevant sagittal, frontal (coronal), and transverse planes (Figure 15-7), and determine any angle of ankylosis or any restricted motion that is present.
5. Perform at least three measurements of each motion. Determine which measurements meet reproducibility criteria described under general measurement principles described in Section 15.8b. Calculate the average of each set of three measurements and determine whether the three measurements in each set fall within 5° or 10% of the mean, whichever is larger.
6. If the measurements do not meet the consistency requirements described in step 5, perform additional tests until the reproducibility criteria are satisfied, up to a maximum of six. If the test results remain inconsistent after six measurements, repeat the tests at a later date or disallow impairment related to that motion.
7. Use the maximum motion from a reproducible set of measurements to determine any impairment rating from the appropriate tables, based on the spinal region and type of movement. Refer to Section 15.8c, Ankylosis and Motion With Ankylosis, if there are several range-of-motion or ankylosis impairments in a region. For example, an individual who can flex the cervical spine from 30° to 60° but who lacks 30° of motion in reaching the neutral 0° position has restricted end motion and the same estimated impairment as if he or she had fixed ankylosis at 30° of cervical flexion. According to Table 15-12, the individual's impairment is 30% of the whole person. If there are impairments due to loss of motion in more than one plane in the same spinal region (extension, flexion, or rotation), the impairments are added to determine total impairment due to loss of motion in a spinal region.
8. Determine any impairments due to neurologic deficits, such as radiculopathy or spinal nerve injury. Refer to Table 15-15 for the procedure to evaluate the sensory deficit. Use Table 15-16 to determine the procedure for estimating loss of strength. Apply these tables to Table 15-17 (cervical and thoracic nerve roots) or Table 15-18 (lumbar and sacral nerve roots) as needed. Convert the neurologic impairments, initially calculated as upper or lower extremity, into a whole person impairment.
9. Combine the diagnosis-based (Table 15-7) and physical examination–based (mobility and neurologic) impairment percents using the Combined Values Chart (p. 604).
10. Repeat steps 1 through 9 for either of the other two spinal regions with significant involvement related to the primary diagnosis.
11. Combine the regional impairments into a single whole person impairment using the Combined Values Chart (p. 604).
12. Combine the whole person spine impairment with whole person ratings for any other organ system using the Combined Values Chart, if indicated.
13. Record the results of the evaluation on the Spine Impairment Summary form (see Table 15-20).

Instructions for Using Table 15-7

1. Use this table only when the ROM method is used.
2. Identify the most significant (impairing) diagnosis of the primarily involved region (lumbar, thoracic, or cervical).
3. The diagnosis-based impairment percent should be combined with range-of-motion impairment estimates and whole person impairment estimates involving sensation, weakness, and other conditions of the musculoskeletal, nervous, or other organ systems.
4. Combine the diagnosis-based, range-of-motion, and other whole person impairment estimates using the Spine Impairment Summary form (Table 15-20).
5. Repeat for other involved spine regions and combined regional impairments if those exist.

Table 15-7 Criteria for Rating Whole Person Impairment Percent Due to Specific Spine Disorders to Be Used as Part of the ROM Method*

Disorder	% Impairment of the Whole Person		
	Cervical	Thoracic	Lumbar
I. Fractures			
A. Compression of one vertebral body.			
0%-25%	4	2	5
26%-50%	6	3	7
> 50%	10	5	12
B. Fracture of posterior element (pedicle, lamina, articular process, transverse process).	4	2	5
Note: An impairment due to compression of a vertebra and one due to fracture of a posterior element are combined using the Combined Values Chart (p. 604). Fractures or compressions of several vertebrae are combined using the Combined Values Chart.			
C. Reduced dislocation of one vertebra.	5	3	6
If two or more vertebrae are dislocated and reduced, combine the estimates using the Combined Values Chart.			
An unreduced dislocation causes impairment until it is reduced; the physician should then evaluate the impairment on the basis of the individual's condition with the dislocation reduced.			
If no reduction is possible, the physician should evaluate the impairment on the basis of the range-of-motion and neurologic findings according to criteria in this chapter and Chapter 13, The Central and Peripheral Nervous System.			
II. Intervertebral disk or other soft-tissue lesion			
Diagnosis must be based on clinical symptoms and signs and imaging information.			
A. Unoperated on, with no residual signs or symptoms.	0	0	0
B. Unoperated on, with medically documented injury, pain, and rigidity* associated with none to minimal degenerative changes on structural tests.†	4	2	5
C. Unoperated on, stable, with medically documented injury, pain, and rigidity* associated with moderate to severe degenerative changes on structural tests;† includes herniated nucleus pulposus with or without radiculopathy.	6	3	7
D. Surgically treated disk lesion without residual signs or symptoms; includes disk injection.	7	4	8
E. Surgically treated disk lesion with residual, medically documented pain and rigidity.	9	5	10
F. Multiple levels, with or without operations and with or without residual signs or symptoms.	Add 1% per level		
G. Multiple operations *with* or without residual signs or symptoms			
1. Second operation	Add 2%		
2. Third or subsequent operation	Add 1% per operation		
III. Spondylolysis and spondylolisthesis, not operated on			
A. Spondylolysis or grade I (1%-25% slippage) or grade II (26%-50% slippage) spondylolisthesis, accompanied by medically documented injury that is stable, and medically documented pain and rigidity with or without muscle spasm.	6	3	7
B. Grade III (51%-75% slippage) or grade IV (76%-100% slippage) spondylolisthesis, accompanied by medically documented injury that is stable, and medically documented pain and rigidity with or without muscle spasm.	8	4	9
IV. Spinal stenosis, segmental instability, spondylolisthesis, fracture, or dislocation, operated on			
A. Single-level decompression without spinal fusion and without residual signs or symptoms	7	4	8
B. Single-level decompression without spinal fusion with residual signs or symptoms	9	5	10
C. Single-level spinal fusion with or without decompression without residual signs or symptoms	8	4	9
D. Single-level spinal fusion with or without decompression with residual signs and symptoms	10	5	12
E. Multiple levels, operated on, with residual, medically documented pain and rigidity.	Add 1% per level		
1. Second operation	Add 2%		
2. Third or subsequent operation	Add 1% per operation		

* The phrase "medically documented injury, pain, and rigidity" implies not only that an injury or illness has occurred but also that the condition is stable, as shown by the evaluator's history, examination, and other diagnostic data, and that a permanent impairment exists, which is at least partially due to the condition being evaluated.

† Structural tests include radiographs, myelograms with and without CT scan, CT scan and MRI with and without contrast, and diskogram with and without CT scan.

15.9 ROM: Lumbar Spine

15.9a Flexion and Extension

Two-Inclinometer Technique

1. Provide information about the test and allow warm-up within pain tolerance. Warm-up exercises, as described in Section 15.8a, are done as tolerated by the individual, based on physician judgment.
2. The individual should be standing with knees extended and weight balanced on both feet, ideally with hands on hips for support to permit greater motion. The spine should be in the neutral position while the inclinometers are set at 0° (See Figure 15-8a). Locate and place horizontal skin marks over the T12 spinous process and the sacrum. Center the first inclinometer aligned in the sagittal plane, over the mark for the T12 spinous process. Center the second inclinometer over the sacral horizontal mark. It is generally best to place the sacral mark at the midpoint of the posterior superior iliac spine because if the mark is placed too high on the sacral convexity, the inclinometer may be displaced during extension. Be certain of the bony landmarks.
3. Instruct the individual to flex the trunk as far as possible (Figure 15-8b), again recording both inclinometer angles and subtracting the sacral (hip) from the T12 inclinometer angle to obtain true lumbar flexion angle. Ask the individual to return the trunk to the neutral position.

Figure 15-8 Two-Inclinometer Technique for Measuring Lumbar Flexion and Extension

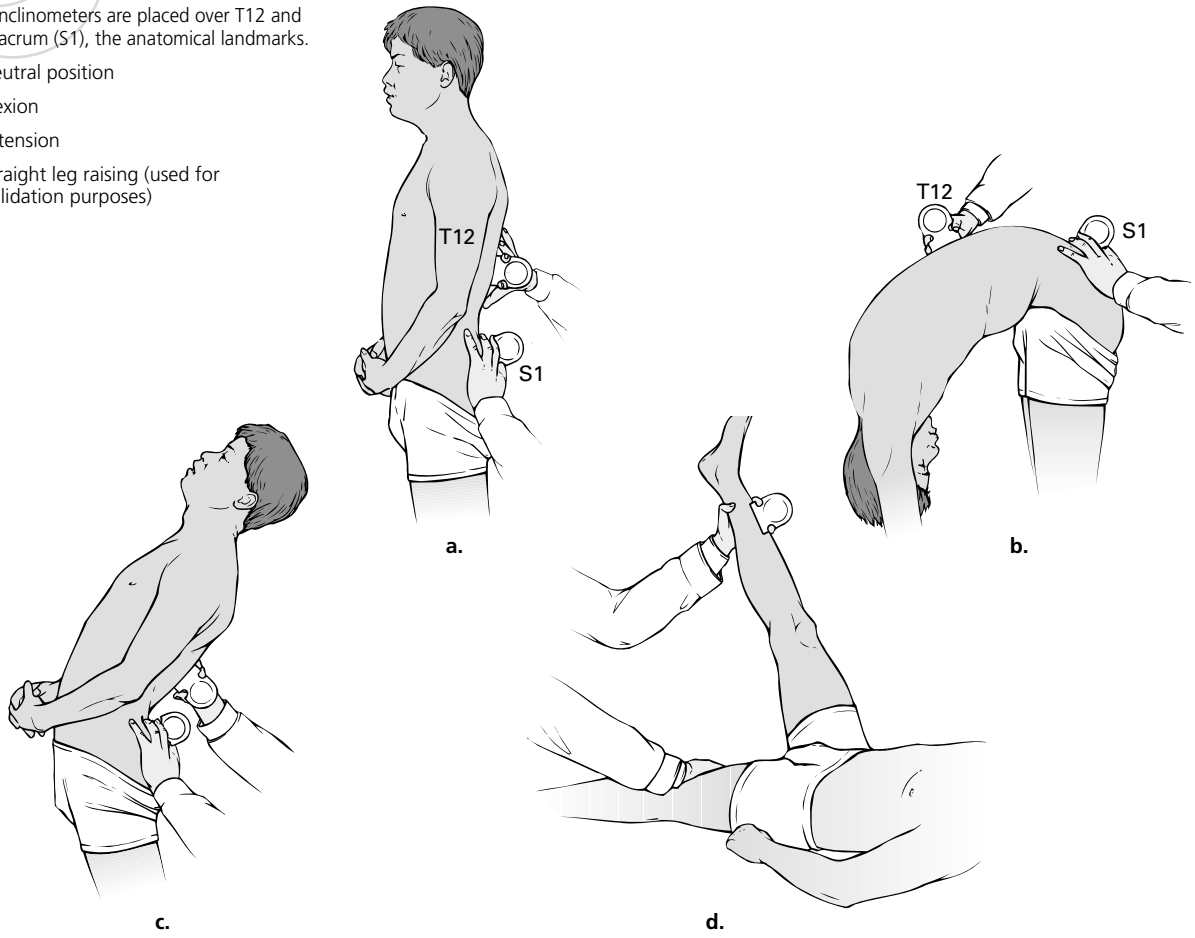
The inclinometers are placed over T12 and the sacrum (S1), the anatomical landmarks.

a. neutral position

b. flexion

c. extension

d. straight leg raising (used for validation purposes)



4. Ask the individual to extend maximally while holding the inclinometers firmly, and record both angles (Figure 15-8c). Subtract the sacral (hip) inclination from the T12 inclinometer angle to obtain the true lumbar extension angle. Return the trunk to the neutral position (verify that the inclinometers are still at 0°).
5. Repeat the procedure at least three times and at most six times for flexion and extension to obtain a valid measurement set (three consecutive, reproducible measurements). Only the true lumbar spine flexion and extension angles need to be consistently measured within 5° if the average is less than 50°, or within 10° if the average is greater than 50°. The impairment is based on the maximum true extension and flexion angles from within the three measurements. The average of the three is only used to determine consistency.
6. An accessory validity test can be performed for lumbosacral flexion and extension.[35] In this test, record the straight-leg-raising angle of the supine individual by placing an inclinometer on each tibial crest with the knees extended and the hip flexed (Figure 15-8d). Compare the straight-leg-raising angle to the sum of the sacral flexion and extension (sacral or hip motion) angles (Figures 15-9a and 15-9c). If the straight-leg-raising angle exceeds the sum of sacral flexion and extension angles by more than 15°, the lumbosacral flexion test is invalid. Normally, the straight-leg-raising angle is about the same as the sum of the sacral flexion-extension angle. If the individual resists passive SLR without other evidence of radiculopathy, the accessory test is also invalid. If invalid, the examiner should either repeat the flexion-extension test or disallow impairment for lumbosacral spine flexion and extension.

   Tightest SLR – [sacral flexion + sacral extension] ≤ 15° for validity (assumes sacral flexion and extension are less than normal).

   Note: This accessory validity test is useful only when sacral flexion plus extension is less than the average for normal individuals (ie, 65° for women and 55° for men). At these levels or above, the difference between sacral motion and supine straight leg raising will usually exceed 15° because the hamstring and gluteal muscles are contracted in the standing flexed position and relaxed in the supine position. However, below the threshold of 65° for women and 55° for men, the tightest supine straight-leg-raising angle should not be more than 15° greater than the combined sacral (hip) flexion and extension angle in the standing position.

   Example of the accessory validity test: A 40-year-old man has a lumbar extension and flexion of 10° and 60°, respectively, with a sacral extension angle of 10° and sacral flexion measurement of 20°. Total sacral motion is 20° + 10°, or 30°. The straight-leg-raising angle is 70°. The measured left straight-leg-raising angle is the tighter one, 70°. The difference between 70° and 30° is greater than 15°, which indicates the results are invalid. The validity test is applicable because the individual's total sacral motion, 30°, is less than the normal 55°. The examiner has the choice of either encouraging the individual to repeat the test with greater effort or invalidating (disallowing) any finding of lumbar spine ROM impairment in the sagittal plane.
7. Once obtaining the lumbar flexion and extension, use Table 15-8 to determine impairment of the whole person. Notice that when interpreting Table 15-8, the physician must take into account the sacral (hip) flexion angle when assessing impairment due to limited lumbar spine flexion because individuals with limited hip flexion have increased impairment with limited lumbar flexion.

Table 15-8 Impairment Due to Abnormal Motion of the Lumbar Region: Flexion and Extension*

The proportion of flexion and extension of total lumbosacral motion is 75%.		
Sacral (Hip) Flexion Angle (°)	**True Lumbar Spine Flexion Angle (°)**	**% Impairment of the Whole Person**
45+	60+	0
	45	2
	30	4
	15	7
	0	10
30-45	40+	4
	20	7
	0	10
0-29	30+	5
	15	8
	0	11

True Lumbar Spine Extension From Neutral Position (0°) to:	**Degrees of Lumbosacral Spine Motion**		**% Impairment of the Whole Person**
	Lost	**Retained**	
0	25	0	7
10	15	10	5
15	10	15	3
20	5	20	2
25	0	25	0

* Use this table only if the sum of sacral (hip) flexion and sacral (hip) extension is within 15° of the straight-leg-raising test on the tighter side; see text.

Ankylosis

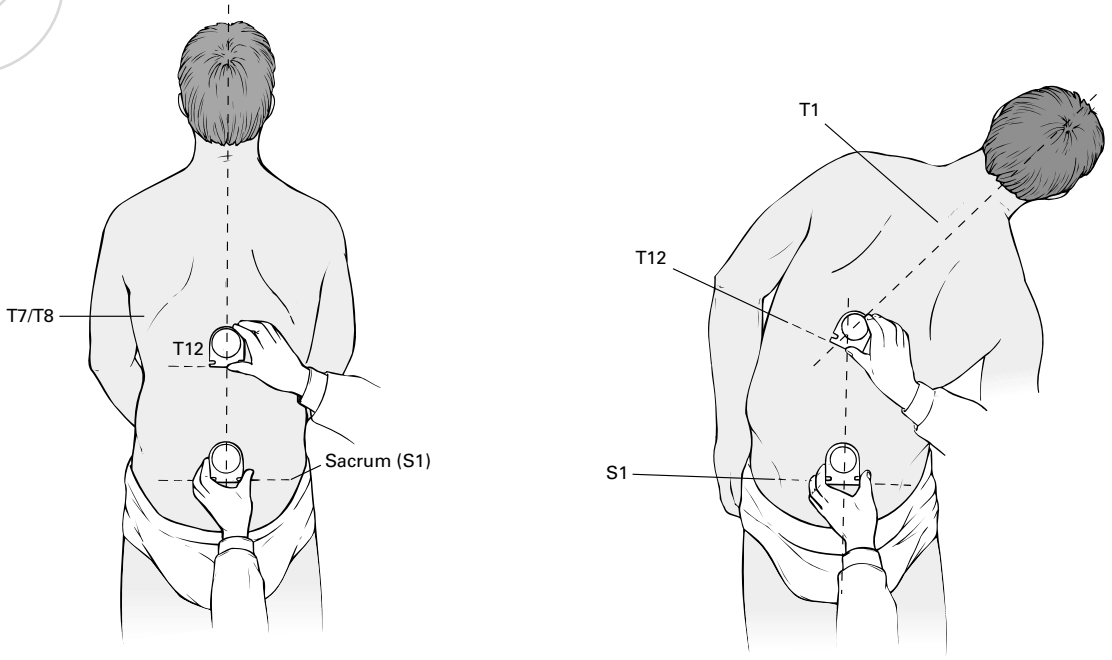
Ankylosis in the lumbosacral spine is rare. It is important mainly if immobility occurs in both the hips and lumbar spine, so the neutral position cannot be attained in the sagittal plane.

Isolated fusion of either a hip or two or more lumbar vertebrae places larger stresses on adjacent segments but does not lead to mechanical failure of the lumbosacral region. Ankylosis impairments related to fusion of the hip or part of the hip motion complex should be evaluated according to Table 15-8 on abnormal motion of the lumbosacral region.

Lateral Bending (Flexion): Two-Inclinometer Technique

1. Provide information to the individual about the procedure and allow for the appropriate warm-up exercises.
2. With the individual standing erect with knees extended, locate and place horizontal skin marks over the T12 spinous process and the sacrum. Verify with the inclinometer that the skin marks are truly horizontal; do not rely solely on visual assessment. Place the first inclinometer aligned in the frontal (coronal) plane over the T12 spinous process and hold the second over the sacrum (Figure 15-9a). The trunk should be in the neutral position while the inclinometers show gravity at 0°.
3. Instruct the individual to bend the trunk laterally to the left and record both angles. Subtract the sacral (hip) inclination angle from the T12 inclination angle to determine the lumbar left lateral angle. Ask the individual to return to the neutral position.

Figure 15-9 Two-Inclinometer Technique for Measuring Lumbosacral Lateral Bend



a. neutral position **b.** lateral bending

4. Instruct the individual to bend the trunk to the right as far as possible (Figure 15-9b), again recording both inclinometer angles and subtracting the sacral (hip) angle from the T12 inclinometer angle to obtain the lumbar right lateral bending angle. Ask the individual to return to the neutral position.
5. Repeat the procedure at least three times per side. To be valid, three of six consecutive measurements must lie within 5° or 10% of the mean, whichever is greater. The impairment estimate is based on the highest (least impairing) angle of a valid set. The mean is used only for a test of reproducibility.

With measurements for left and right lateral bending and any ankylosis, use Table 15-9 to determine the whole person impairment.

Add the impairments within the lumbar region. If other regions are impaired, the lumbar impairment should be *combined* with the other region impairment using the Combined Values Chart (p. 604).

Table 15-9 Impairment Due to Abnormal Motion and Ankylosis of the Lumbar Region: Lateral Bending

Abnormal Motion **Average range of left and right lateral bending is 50°; the proportion of total lumbosacral motion is 40% of the total spine.**				
a.	**Left Lateral Bending From Neutral Position (0°) to:**	**Degrees of Lumbosacral Motion**		**% Impairment of the Whole Person**
		Lost	**Retained**	
	0	25	0	5
	10	15	10	3
	15	10	15	2
	20	5	20	1
	25	0	25	0
b.	**Right Lateral Bending From Neutral Position (°) to:**	**Degrees of Lumbosacral Motion**		**% Impairment of the Whole Person**
		Lost	**Retained**	
	0	25	0	5
	10	15	10	3
	15	10	15	2
	20	5	20	1
	25	0	25	0
c.	**Ankylosis** **Region Ankylosed at (°):**			
	0 (neutral position)			10
	30			20
	45			30
	60			40
	75 (full flexion)			50

Example 15-19
1% Impairment Due to Loss of Left Lateral Bending

Subject: 55-year-old man.

History: Persisting back pain, worse over the last year; no specific injury identified.

Current Symptoms: Lumbar pain increases with standing or walking for more than 1 hour.

Physical Exam: Measured T12 angles for left lateral bending are 20°, 20°, 30°, and 25°. Corresponding sacral (hip) lateral flexion measurements to the right are 15°, 5°, 10°, and 10°. Subtracting the sacral bending measurements, the true lumbosacral left lateral flexion angles are 5°, 15°, 20°, and 15°, respectively. The first measurement is discarded, being more than 5° less than the mean of 13.75°, but the next three measurements fulfill reproducibility criteria. The best left lateral bending angle is 20°.

Diagnosis: Chronic low back pain.

Impairment Rating: 1% impairment due to loss of left lateral bending (Table 15-9). Obtain the other ROM measurements for the lumbar spine and add the ROM impairments.

Ankylosis

Ankylosis in lumbar spine lateral bending (flexion) is generally associated with a scoliosis and usually produces only limited impairment. Mark the T12 and spinous process and sacrum, and ask the individual to stand in the most erect position possible that corrects the deformity. Using measurements made in the frontal (coronal) plane, subtract the sacral (hip) inclination from the T12 inclination and record the ankylosis angle or the angle of restriction (closest to the 0° neutral position). Consult Table 15-9 for the impairment rating.

Figure 15-10 provides a measurement template for lumbar impairment evaluation using the ROM method.

Figure 15-10 Lumbar Range of Motion (ROM)*

Name _____ Soc. Sec. No. _____ Date _____

Movement	Description	Range					
Lumbar flexion	T12 ROM						
	Sacral ROM						
	True lumbar flexion angle						
	±10% or 5°	Yes	No				
	Maximum true lumbar flexion angle						
	% Impairment						
Lumbar extension	T12 ROM						
	Sacral ROM						
	True lumbar extension angle						
	±10% or 5°	Yes	No				
	Maximum true lumbar extension angle			(Add sacral flexion and extension ROM and compare to tightest straight-leg-raising angle)			
	% Impairment						
Straight leg raising (SLR), left	Left SLR						
	±10% or 5°	Yes	No	(If tightest SLR ROM exceeds sum of sacral flexion and extension by more than 15%, lumbar ROM test is invalid)			
	Maximum SLR Left						
Straight leg raising (SLR), right	Right SLR						
	±10% or 5°	Yes	No	(If tightest SLR ROM exceeds sum of sacral flexion and extension by more than 15%, lumbar ROM test is invalid)			
	Maximum SLR right						
Lumbar left lateral bending	T12 ROM						
	Sacral ROM						
	Lumbar left lateral bending angle						
	±10% or 5°	Yes	No				
	Maximum lumbar left lateral bending angle						
	% Impairment						
Lumbar right lateral bending	T12 ROM						
	Sacral ROM						
	Lumbar right lateral bending angle						
	±10% or 5°	Yes	No				
	Maximum lumbar right lateral bending angle						
	% Impairment						
Lumbar ankylosis in lateral bending	Position						
	% Impairment			(Excludes any impairment for abnormal flexion or extension motion)			
Total lumbar range-of-motion and ankylosis* impairment _____ %							

* If ankylosis is present, combine the ankylosis impairment with the range-of-motion impairment (Combined Values Chart, p. 604).

If ankyloses in several planes are present, combine the ankylosis estimates (Combined Values Chart), then combine the result with the range-of-motion impairment.

Example 15-20
15% Impairment Due to Limitation (Ankylosis) of Lateral Bending

Subject: 40-year-old man.

History: Fell from a ladder, landed on his buttocks, and fractured L3 and L4 vertebrae with wedging toward the left side.

Current Symptoms: Low back pain after heavy lifting, with radiating pain to the knee.

Physical Exam: Leaning to the left; cannot straighten his back to a neutral position.

Clinical Studies: Inclinometric measurements show his starting position is at 20° of left lateral bending with further motion to 30°. The 20° is closest to the neutral position and is considered an ankylosis of 20° for rating purposes. Use the Ankylosis section of Table 15-9.

Diagnosis: Compression fractures of L3 and L4 with apex left lateral wedging.

Impairment Rating: 15% impairment of the whole person due to limitation (ankylosis) of lateral bending.

Comment: Add to this any impairments for other ROM deficits in the lumbar spine, then combine the total ROM impairment with those for the compression fractures (Table 15-7) and neurologic deficits, if any.

15.10 ROM: Thoracic Spine

15.10a Flexion and Extension

Thoracic flexion and extension are relatively limited motions. The amount of extension is determined mainly by the individual's posture and the degree of fixed kyphosis or curvature of the thoracic spine. To determine the ranges of motion of this region, the individual is measured in the military brace posture to obtain the angle of extension or minimum kyphosis. Then, with the individual fully flexing the thoracic spine, the flexion angle is determined. The angle of minimum kyphosis is actually a measure of ankylosis, and impairment resulting from deformity corresponding to this angle is found in the Ankylosis part of Table 15-10.

Table 15-10 Impairment Due to Abnormal Motion (Flexion) and Ankylosis of the Thoracic Region

Average range of flexion and extension is 50°; the proportion of all thoracic motion is 60% of the total spine.			
Abnormal Motion			
Flexion From Erect Position (Angle of Thoracic Flexion) to:	**Degrees of Thoracic Motion**		**% Impairment of the Whole Person**
	Lost	**Retained**	
0	50	0	4
15	35	15	2
30	20	30	1
60	0	50	0
Ankylosis **Angle of Minimum Kyphosis (°)**			
–30 (Extension thoracic lordosis)			20
0 (neutral)			0
60			5
80			20
100			40

Two-Inclinometer Technique

1. Provide information to the individual, and allow for the appropriate warm-up exercises. Measurements are obtained with the individual standing or sitting.
2. Locate and place horizontal skin marks over the T1 and T12 spinous processes. Place both inclinometers, which do not show gravity 0 automatically against a true vertical surface, such as a wall, and set the neutral 0° positions. Place the inclinometers over the T1 and T12 spinous processes while instructing the individual to maintain the maximally extended military brace posture position (Figures 15-11a and 15-11c). Subtract the T12 inclinometer reading from the T1 inclinometer reading (if both are inclined in the same direction from the vertical) to obtain the angle of minimum kyphosis. If T12 and T1 are inclined in opposite directions from the vertical, add the angles. Find the impairment percent in the Ankylosis part of Table 15-10.
3. Set the inclinometers to 0° with the individual standing in the erect military brace posture. Then ask the individual to fully flex the thoracic spine. Flexing at the hips is permitted. Subtract the T12 inclinometer reading from the T1 reading obtained in step 1 above to obtain the angle of thoracic flexion (Figures 15-11b and 15-11d).
4. Repeat either the sitting or the standing test up to six times to obtain three measurements within 5° of the mean or 10%, whichever is greater.
5. A reproducibility test is done after a positional change, having the standing individual sit or vice versa. If the initial measurements were made standing, seat the individual on a stool, record the neutral 0° position, and ask him or her to flex the thoracic spine maximally from the military brace position. The thoracic flexion sitting angle should be nearly identical to the flexion angle obtained in the erect position.
6. Consult the Abnormal Motion part of Table 15-10 to determine the whole person impairment.

Figure 15-11 Two-Inclinometer Technique for Measuring Angles of Minimum Kyphosis and Thoracic Flexion

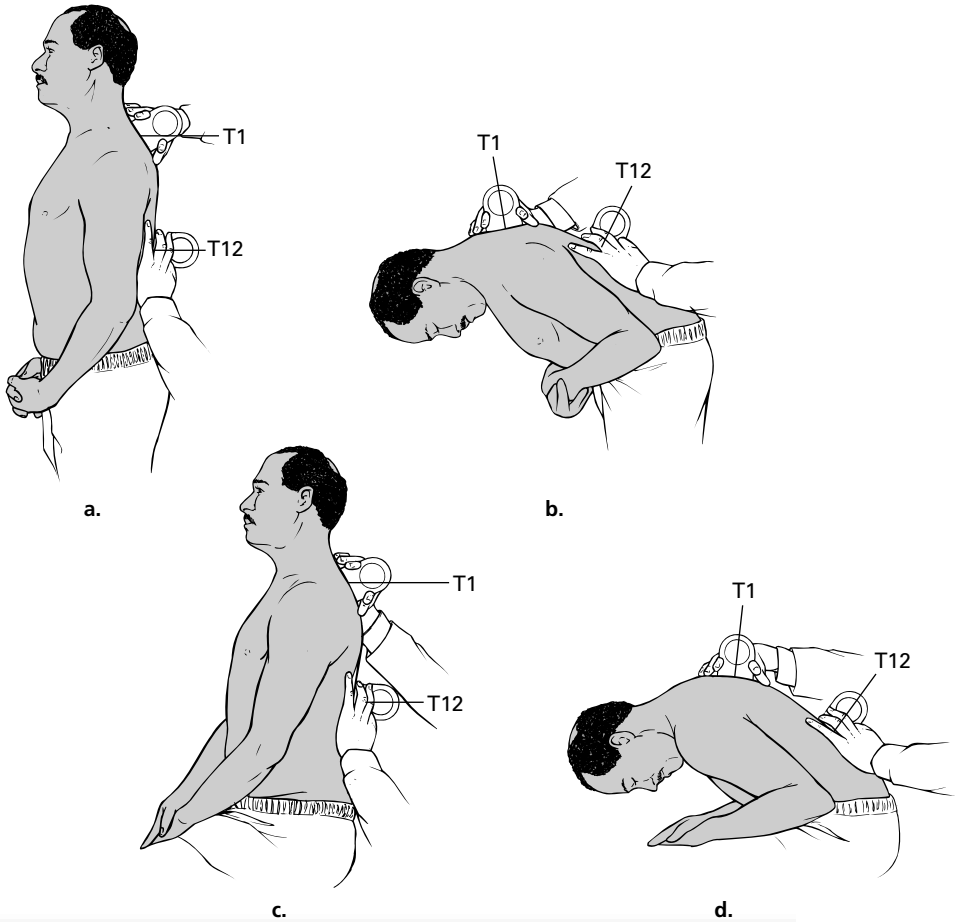
The inclinometers are placed over T1 and T12.

a. standing technique for measuring minimum kyphosis

b. standing technique for measuring flexion

c. sitting technique for measuring minimum kyphosis

d. sitting technique for measuring flexion



Ankylosis

The angle of minimum kyphosis of the thoracic spine may be considered equal to the angle of ankylosis. Excessive kyphosis or thoracic lordosis is evaluated as an impairment according to Table 15-10.

Example 15-21
5% Impairment Due to Ankylosing Spondylitis and Low Back Pain

Subject: 47-year-old man.

History: Ankylosing spondylitis.

Current Symptoms: Chronic low back pain.

Physical Examination: Attempts to extend his thoracic spine fully demonstrate an angle of minimum kyphosis of 60°. With maximum flexion, T1 readings of 35°, 45°, and 55° are recorded, which are matched with T12 flexion angles of 25°, 30°, and 40°, respectively. The angles of thoracic flexion, derived by subtracting the T12 from the T1 angles, are 10°, 15°, and 15°. These three measurements meet validity criteria.

Clinical Studies: Radiographs: consistent with ankylosing spondylitis.

Diagnosis: Ankylosing spondylitis and low back pain.

Impairment Rating: According to Table 15-10, the impairment due to a 60° ankylosis (angle of minimum kyphosis) is 5% whole person impairment. The maximum flexion of 15° is 2% whole person impairment. The total impairment is the greater of the ankylosis and abnormal motion percentages, in this instance, 5%.

Comment: Combine this with impairments from the diagnosis table (Table 15-7).

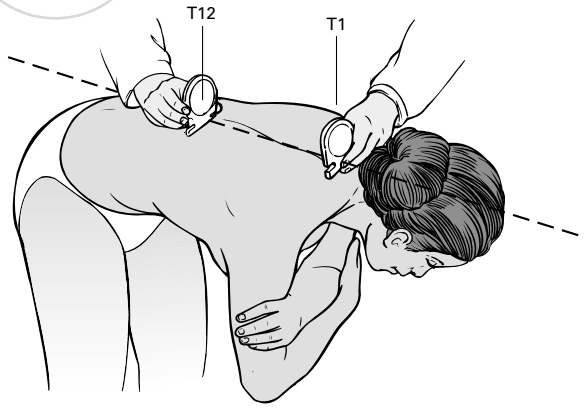
15.10b Rotation

Two-Inclinometer Technique

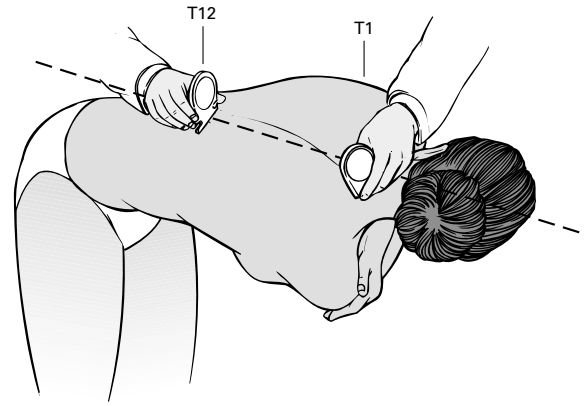
1. Provide information to the individual about the procedure and allow for appropriate warm-up exercises.
2. The individual should be seated or standing, whichever is more comfortable, and in a forward flexed position, with the thoracic spine in as horizontal a position as can be achieved (Figure 15-12a). Locate and place horizontal skin marks over the T1 and T12 spinous processes. The trunk should be in the neutral position for rotation. The inclinometers are set to 0 by placement against a flat, horizontal table or floor if they do not automatically indicate gravity 0°. Place the first inclinometer aligned vertically in the transverse (axial) plane over the T1 spinous process while holding the second over the T12 spinous process.
3. Ask the individual to rotate the trunk maximally to the left and record both angles (Figure 15-12b). Subtract the T12 angle from the T1 angle to obtain the thoracic left rotation angle. Return the trunk to the neutral position (Figure 15-12a).
4. Instruct the individual to rotate the trunk maximally to the right, again recording both inclinometer angles; subtract the T12 angle from the T1 angle to obtain the thoracic right rotation angle.
5. Repeat the procedure three to six times per side to obtain a valid set of three consecutive measurements. The angles of a valid set should be within 5°or 10% of the mean of the set, whichever is greater. The final impairment percent is based on the best (least impairing) angle measured.

Using the best angle of rotation and Table 15-11, determine the whole person impairment.

Figure 15-12 Two-Inclinometer Technique for Measuring Left Thoracic Rotation



a. neutral position



b. rotation

The figure shows the individual standing. The inclinometers are placed at T1 and T12 and aligned in the vertical plane.

Table 15-11 Impairment Due to Abnormal Motion and Ankylosis of the Thoracic Region: Rotation

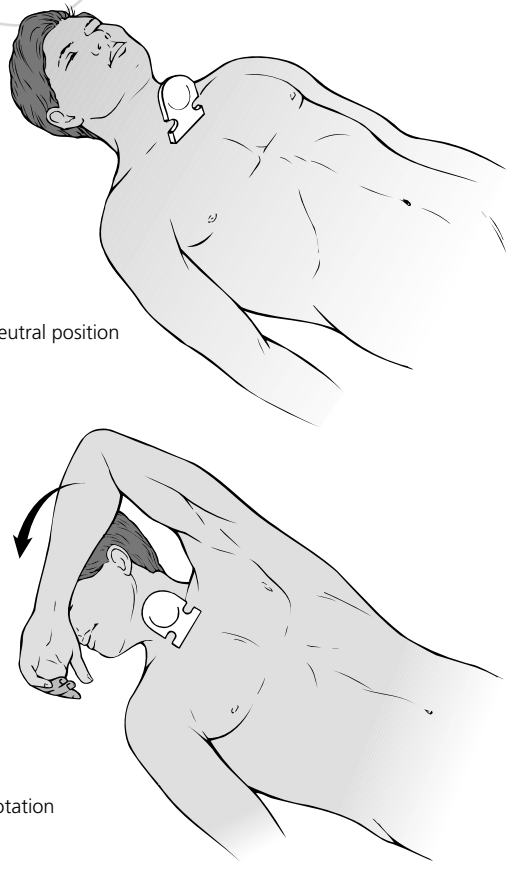
Abnormal Motion **Average range of rotation is 60°;** **the proportion of all thoracic spine motion is 40%.**				
a.	**Left Rotation From Neutral Position (0°) to (°):**	**Degrees of Thoracic Motion**		**% Impairment of the Whole Person**
		Lost	**Retained**	
	0	30	0	3
	10	20	10	2
	20	10	20	1
	30	0	30	0
b.	**Right Rotation From Neutral Position (0°) to (°):**			
	0	30	0	3
	10	20	10	2
	20	10	20	1
	30	0	30	0
c.	**Ankylosis** **Region Ankylosed at (°):**			
	0 (neutral position)			6
	5			10
	25			20
	35 (full left or right rotation)			30

Example: An individual's T1 rotation to the left measures 15°, 20°, and 15°. Corresponding T12 rotation angles are 5°, 10°, and 5°. The measurements are valid, and the left rotation angle is 10°. The whole person impairment is 2% due to loss of rotation (Table 15-11).

15.10c Alternative Thoracic Rotation Technique

1. The individual lies supine on the exam table. Stabilize the hips and pelvis. Place the inclinometer across the manubrium, just below the sternal notch. The trunk should be in the neutral position and the inclinometer set at 0° gravity if it is not automatically set to 0 (Figure 15-13a).
2. Ask the individual to rotate the trunk maximally to the left and record the angle on the sternum inclinometer, making certain an assistant holds the pelvis to the table without permitting rotation. Because the angle actually measures left thoracolumbar rotation, subtract 5°, the average lumbar rotation, to obtain the estimated thoracic rotation.
3. Instruct the individual to rotate the trunk maximally to the right (Figure 15-13b), again maintaining pelvic stabilization. Read the sternal inclinometer angle and subtract 5° to obtain the right thoracic rotation angle.

Figure 15-13 Alternative Technique for Measuring Thoracic Spine Rotation



a. neutral position

b. rotation

Only one inclinometer is used. The individual is supine on the exam table with the thoracolumbar spine and pelvis in neutral position. The inclinometer is placed on the manubrium, just below the sternal notch. Stabilize the pelvis.

Ankylosis

Rotational ankylosis of the thoracic spine is generally a component of a scoliosis deformity and by itself creates only limited impairment. To evaluate this type of ankylosis, use the same posture as for measuring abnormal motion in the thoracic spine, and ask the individual to achieve maximum correction of the rotation deformity. Then subtract the T12 rotation angle from the T1 rotation angle and determine the ankylosis angle or angle of restricted motion. Refer to the Ankylosis part of Table 15-11 to determine the impairment percent.

Figure 15-14 provides a measurement template for thoracic impairment evaluation using the ROM method.

Figure 15-14 Thoracic Range of Motion (ROM)*

Name _____ Soc. Sec. No. _____ Date _____

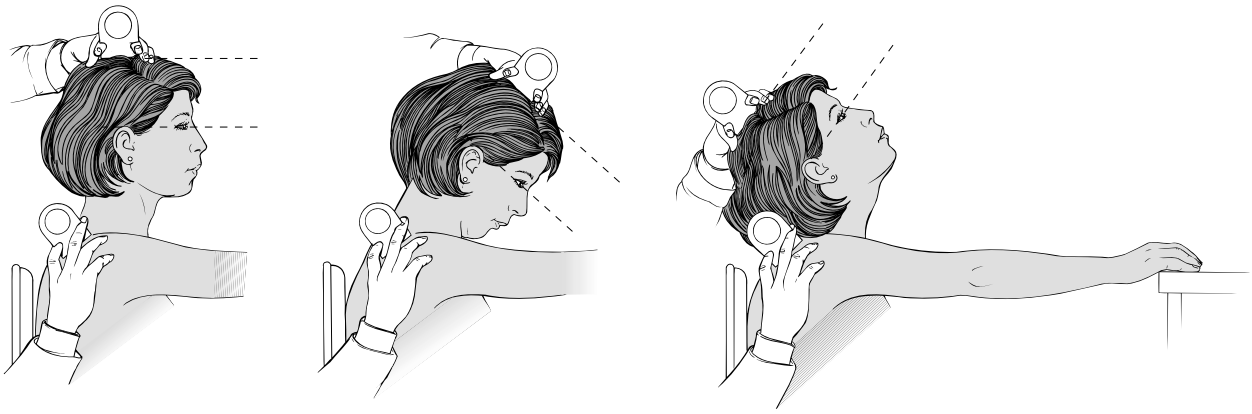
Movement	Description	Range					
Angle of minimum kyphosis (thoracic ankylosis in extension)	T1 reading		XXXX	XXXX	XXXX	XXXX	XXXX
	T12 reading		XXXX	XXXX	XXXX	XXXX	XXXX
	Angle of minimum kyphosis		XXXX	XXXX	XXXX	XXXX	XXXX
	% Impairment due to thoracic ankylosis	(Use larger of either ankylosis or flexion impairment)					
Thoracic flexion	T1 ROM						
	T12 ROM						
	Thoracic flexion angle						
	10% or 5°	Yes	No				
	Maximum thoracic flexion angle						
	% Impairment						
Thoracic left rotation	T1 ROM						
	T12 ROM						
	Thoracic left rotation angle						
	10% or 5°	Yes	No				
	Maximum thoracic left rotation angle						
	% Impairment						
Thoracic right rotation	T1 ROM						
	T12 ROM						
	Thoracic right rotation angle						
	10% or 5°	Yes	No				
	Maximum thoracic right rotation angle						
	% Impairment						
Thoracic ankylosis in rotation	Position			(Excludes any impairment for abnormal flexion or extension motion)			
	% Impairment						
Total thoracic range of motion and ankylosis* impairment _____%							

*If ankylosis is present, combine the ankylosis impairment with the range-of-motion impairment (Combined Values Chart, p. 604).

If ankyloses in several planes are present, combine the ankylosis estimates (Combined Values Chart), then combine the result with the range-of-motion impairment.

Figure 15-15 Two-Inclinometer Technique for Measuring Cervical Flexion and Extension

The individual is sitting and the inclinometers placed over the calvarium and at T1.



a. neutral position **b.** flexion **c.** extension

15.11 ROM: Cervical Spine

15.11a Flexion and Extension

Two-Inclinometer Technique

1. Provide information to the individual about the procedure, and allow for appropriate warm-up exercises.
2. Locate and place a horizontal skin mark over the T1 spinous process. With the individual seated, place the first inclinometer, aligned in the sagittal plane, over the T1 spinous process. Place the second inclinometer at the side of the face, from the corner of the eye to the ear, along a parallel line where the temple of eyeglasses would sit (Figure 15-15a). From this position, set the inclinometer to 0. This represents the 0° true neutral position. Move the second inclinometer to the calvarium, and set the head to the neutral position in both the sagittal and frontal planes, where the inclinometer again reads 0 (Figure 15-15a).
3. Ask the individual to flex maximally and record both angles. Subtract the T1 angle from the calvarium angle to obtain the cervical flexion angle (Figure 15-15b) and record it. Return the head to the neutral position so both inclinometers read 0° again.
4. Instruct the individual to extend the neck as far as possible, keeping the chin close to the sternum, again recording both inclinometer angles. Subtract the T1 angle from the calvarium angle to obtain the cervical extension angle (Figure 15-15c). Ask the individual to return the head to the neutral position.
5. Repeat the procedure three times. The cervical flexion and extension angles should be consistently measured within 5° or 10%, whichever is greater. The impairment rating is based on the greatest angle of a valid set of three consecutive measurements.
6. Using the largest valid cervical flexion and extension measurements, obtain the whole person impairment rating for cervical flexion and extension using Table 15-12.
7. *Add* the cervical flexion and extension impairment ratings and *combine* the sum with any ratings for diagnostic criteria (Table 15-7) and/or neural impairment.

Ankylosis

1. Note whether there is motion of the cervical spine in the sagittal plane or whether the spine is unable either to flex or extend beyond the neutral point. Determine if the ankylosis or restricted motion is in flexion or extension. If some motion is possible in the sagittal plane, ask the individual to hold the position closest to the neutral point.
2. Place the inclinometer's base against a vertical surface to set the inclinometer to the neutral 0 position. Then place it at the side of the face, from the corner of the eye to the ear, along a parallel line where eyeglass temples would lie (Figure 15-15b). Move the inclinometer to the calvarium and set the head to the neutral position in both the sagittal and frontal planes, where the inclinometer again reads 0 (Figure 15-15b).
3. Place the second inclinometer at T1 and record the angle. Subtract or add the T1 angle from the first-read angle to obtain the angle of ankylosis in either flexion or extension.
4. Consult the Ankylosis section of Table 15-12 to determine the whole person impairment.
5. Add the impairment percent for left rotation and right rotation. Their sum is the whole person impairment contributed by abnormal rotation of the cervical region.

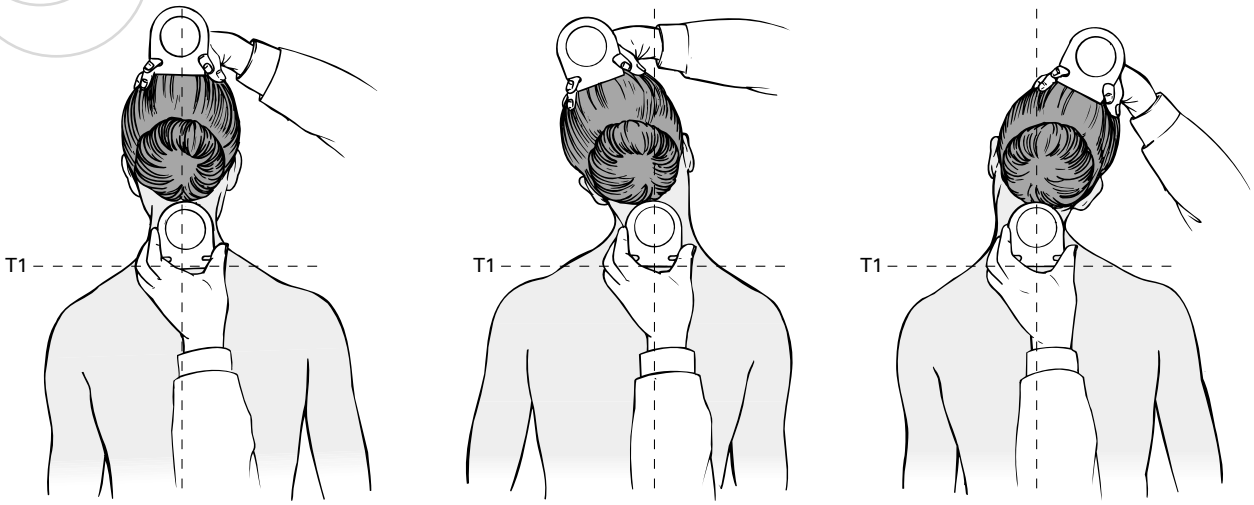
Table 15-12 Cervical Region Impairment From Abnormal Flexion or Extension or Ankylosis

Abnormal Motion
Average range of flexion and extension is 110°; the proportion of all cervical motions is 40%.

a.	Flexion From Neutral Position (0°) to (°):	Degrees of Cervical Motion		% Impairment of the Whole Person
		Lost	Retained	
	0	50	0	5
	15	35	15	4
	30	30	20	2
	50	0	50	0
b.	**Extension From Neutral Position (0°) to (°):**	**Degrees of Cervical Motion**		**% Impairment of the Whole Person**
		Lost	**Retained**	
	0	60	0	6
	20	40	20	4
	40	20	40	2
	60	0	60+	0
c.	**Region Ankylosed at (°):**			
	0 (neutral position)			12
	15			20
	30			30
	50 (full flexion)			40
d.	**Region Ankylosed at (°):**			
	0 (neutral position)			12
	20			20
	40			30
	60 (full extension)			40

Example: A 55-year-old man has an extension deformity on attempted flexion. Inclinometer reading from the calvarium is 15° extension from the neutral 0° position. The T1 angle is 5° of flexion from neutral 0°. In this case, because the angles are in different directions from the neutral position, they are *added*, and the cervical spine thus is ankylosed at 20° extension. This is considered a 20% whole person impairment (Table 15-12).

Figure 15-16 Two-Inclinometer Technique for Measuring Cervical Lateral Flexion



a. neutral position **b.** left lateral bending **c.** right lateral bending

The individual is sitting, and the inclinometers are set to 0, with the eye-ear line as the 0 reference (see text for description) and placed over the calvarium and T1.

15.11b Lateral Bending

Two-Inclinometer Technique

1. Provide information to the individual about the procedure and allow for appropriate warm-up exercises.
2. Place a skin mark over the T1 spinous process. With the individual in the seated position, place the first inclinometer aligned in the coronal plane over the T1 spinous process while holding the second inclinometer over the calvarium (Figure 15-16a). The head should be in the neutral position while the inclinometers are set at 0°.
3. Ask the individual to tilt the head maximally to the left and record both angles (Figure 15-16b). Subtract the T1 angle from the calvarium angle to determine the degrees of left lateral bending. Return the head to the neutral position.
4. Instruct the individual to tilt the head maximally to the right as far as possible, recording both inclinometer angles. Subtract the T1 angle from the calvarium angle to determine cervical right lateral bending (Figure 15-16c).
5. Repeat the above procedure at least three times. The angles measured should be within 5° or 10% of the mean of the three measurements, whichever is greater. The measurement used for impairment rating is the greatest angle of a valid set of three consecutive measurements.
6. Consult Table 15-13 to determine the whole person impairment related to abnormal lateral flexion of the cervical region.

Add the impairment percent from left lateral bending and right lateral bending. Their sum represents the whole person impairment related to abnormal lateral bending of the cervical region.

Table 15-13 Impairment Due to Abnormal Motion and Ankylosis of the Cervical Region: Lateral Bending

Abnormal Motion **The average range of lateral bending is 90°; the proportion of all cervical motions is 25%.**				
a.	**Left Lateral Bending From Neutral Position (0°) to (°):**	**Degrees of Cervical Motion**		**% Impairment of the Whole Person**
		Lost	**Retained**	
	0	45	0	4
	15	30	15	2
	30	15	30	1
	45	0	45	0
b.	**Right Lateral Bending From Neutral Position (0°) to (°):**	**Degrees of Cervical Motion**		**% Impairment of the Whole Person**
		Lost	**Retained**	
	0	45	0	4
	15	30	15	2
	30	15	30	1
	45	0	45	0
c.	**Ankylosis** **Region Ankylosed at (°):**			
	0 (neutral position)			8
	15			20
	30			30
	45 (full left or right rotation)			40

Example: The left bending flexion angles measured from the calvarium are 20°, 35°, 35,° and 40°. The corresponding T1 measurements are 5°, 5°, 10°, and 10°. The true left lateral degrees of bending are 15°, 20°, 25°, and 30°. The 15° is discarded. The other three measurements fulfill the validation criteria, being more than 5° from the mean of 25°. The greatest left lateral bending angle of the three trials is 30°, and the impairment rating due to left lateral bending limitation is 1% (Table 15-13).

Ankylosis

1. Place both inclinometer bases against a desk or tabletop and adjust until they read 0°, or the neutral position.

2. Place one inclinometer in the frontal plane at T1 (Figure 15-16b) and the second inclinometer over the calvarium.

3. Determine whether the individual has cervical lateral motion or is unable to attain the neutral position. If there is motion and the individual cannot reach the neutral position, read the angle closest to neutral 0. This is the angle of ankylosis used for rating (Figure 15-16b).

Consult the Ankylosis section of Table 15-13 to determine the whole person impairment.

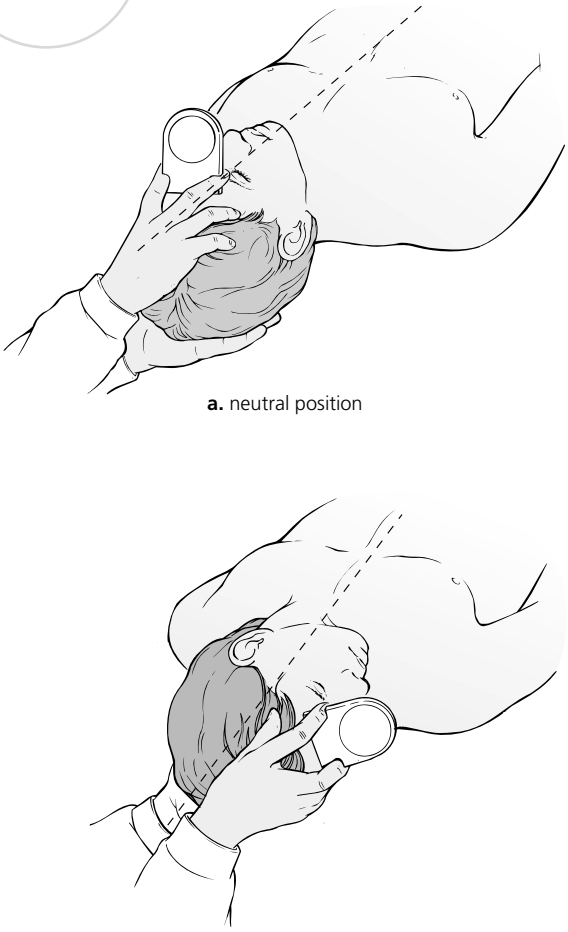
15.11c Cervical Rotation

Because the technique for cervical evaluation stabilizes the trunk in the supine position, with the shoulders on the table, only one inclinometer is required for measurement of rotation.

1. Provide information to the individual about the procedure, and allow for appropriate warm-up exercises. Set the inclinometer to 0° or the gravity position.
2. Have the individual lie supine on a flat exam table with shoulders exposed to permit observation of any truncal (thoracolumbar) rotation. Stand at the head of the table and place the inclinometer in the transverse plane with the base applied to the forehead (Figure 15-17a). Record the neutral 0° position with the individual's nose pointing to the ceiling.
3. Ask the individual to rotate the head maximally to the left, and record the cervical left rotation angle.
4. Ask the individual to rotate the head maximally to the right, and record the cervical right rotation angle (Figure 15-17b).
5. Repeat the procedure three to six times to obtain a valid set of three consecutive measurements. The left and right cervical rotation angles should be within 5° or 10% of the mean of a valid set, whichever is greater. The impairment rating is based on the greatest angle of a valid set.

Example: Left cervical rotation is 15°, 35°, 55°, 60°, and 55°. The initial two measurements are discarded, while the others are close enough to be valid. The largest measurement, 60°, is used and corresponds to a whole person impairment estimate for abnormal left cervical rotation of 1% (Table 15-14).

Figure 15-17 Measuring Cervical Rotation



a. neutral position

b. right rotation

Table 15-14 Impairment Due to Abnormal Motion and Ankylosis of the Cervical Region: Rotation

Abnormal Motion **Average range of rotation is 160°;** **the proportion of all cervical motion is 35%.**				
a.	**Left Rotation From Neutral Position (0°) to (°):**	**Degrees of Cervical Motion**		**% Impairment of the Whole Person**
		Lost	**Retained**	
	0	80	0	6
	20	60	20	4
	40	40	40	2
	60	20	60	1
	80	0	80+	0
b.	**Right Rotation From Neutral Position (0°) to (°):**	**Degrees of Cervical Motion**		**% Impairment of the Whole Person**
		Lost	**Retained**	
	0	80	0	6
	20	60	20	4
	40	40	40	2
	60	20	60	1
	80	0	80+	0
c.	**Ankylosis** **Region Ankylosed at (°):**			
	0 (neutral position)			12
	20			20
	40			30
	60			40
	80 (full right or left rotation)			50

Ankylosis

1. Determine whether the individual has cervical axial motion and is unable to attain the neutral position. If the individual has some motion, ask him or her to maintain the position closest to neutral and record the ankylosis angle closest to neutral (Figure 15-17).
2. Place the inclinometer on the calvarium with the cervical region in the ankylosis position, and record the ankylosis angle.
3. Consult the Ankylosis part of Table 15-14 to determine the whole person impairment.

Figure 15-18 provides a template for evaluating cervical impairment using the ROM method.

Figure 15-18 Cervical Range of Motion (ROM)*

Name _____ Soc. Sec. No. _____ Date _____

Movement	Description	Range					
Cervical flexion	Calvarium angle						
	T1 ROM						
	Cervical flexion angle						
	±10% or 5°	Yes	No				
	Maximum cervical flexion angle						
	% Impairment						
Cervical extension	Calvarium angle						
	T1 ROM						
	Cervical extension angle						
	±10% or 5°	Yes	No				
	Maximum cervical extension angle						
	% Impairment						
Cervical ankylosis in flexion/extension	Position						
	% Impairment			(Excludes any impairment for abnormal flexion or extension motion)			
Cervical left lateral bending	Calvarium angle						
	T1 ROM						
	Cervical left lateral flexion angle						
	±10% or 5°	Yes	No				
	Maximum cervical right lateral flexion angle						
	% Impairment						
Cervical right lateral bending	Calvarium angle						
	T1 ROM						
	Cervical right lateral flexion angle						
	±10% or 5°	Yes	No				
	Maximum cervical right lateral flexion angle						
	% Impairment						
Cervical ankylosis in lateral bending	Position						
	% Impairment			(Excludes any impairment for abnormal lateral flexion or extension motion)			
Cervical left rotation	Cervical left rotation angle						
	±10% or 5°	Yes	No				
	Maximum cervical left rotation angle						
	% Impairment						
Cervical right rotation	Cervical right rotation angle						
	±10% or 5°	Yes	No				
	Maximum cervical right rotation angle						
	% Impairment						
Cervical ankylosis in rotation	Position						
	% Impairment			(Excludes any impairment for abnormal rotation)			
Total cervical range of motion and ankylosis* impairment _____ %							
Total cervical range of motion = % impairments of flexion + extension + left lateral bending + right lateral bending + left rotation + right rotation							

* If ankylosis is present, combine the ankylosis impairment with the range-of-motion impairment (Combined Values Chart, p. 604). If ankyloses in several planes are present, combine the estimates (Combined Values Chart), then combine the result with the range-of-motion impairment.

15.12 Nerve Root and/or Spinal Cord

When using the ROM method, it is important to consider any nerve root or spinal cord impairment. Injury or illness to the cervical spine may produce nerve root compression manifested by sensory or motor loss in the upper extremities, as well as long tract signs from spinal cord compression. In the thoracic spine, spinal cord compression or injury may produce long tract signs, but nerve roots are uncommonly compressed. In the lumbosacral spine, spinal cord involvement is rare because the cord typically ends at L1, although nerve root compression (cauda equina or isolated root[s]) affecting the lower extremities is common. If any neural impairment is identified, proceed with the following evaluation:

1. Identify the nerve(s) involved, based on the clinical evaluation and the dermatome distribution charts for the lower (Figure 15-1) and upper extremity (Figure 15-2).
2. Determine the extent of any sensory and motor loss due to nerve impairment, based on Tables 15-15 and 15-16.
3. Find the maximum impairment due to nerve dysfunction in Table 15-17 for the upper extremity and Table 15-18 for the lower extremity.
4. Multiply the severity of the sensory or motor deficit by the maximum value of the relevant nerve (Tables 15-17, 15-18). If there is both sensory and motor impairment of a nerve root, the impairment percents are combined (Combined Values Chart, p. 604) to determine the extremity impairment. If both extremities are impaired, the impairment percent for each extremity is determined, converted to whole person impairment, and the two impairment ratings combined using the Combined Values Chart.
5. Convert to whole person impairment by multiplying the upper extremity impairment by 0.6 and the lower extremity impairment by 0.4. To convert any regional ROM spine impairment to whole person impairment, multiply the specific spinal nerve impairment by the regional weight: 0.80 for the cervical spine, 0.40 for the thoracic spine, and 0.90 for the lumbosacral spine. Impairment ratings above 100% are rounded down to 100% since a whole person impairment rating cannot exceed 100%. This is described further in Section 15.14.

If there is bilateral spinal nerve impairment or spinal cord involvement, especially if in conjunction with head injury, consultation with a neurologist and/or neurosurgeon and review of the diagnostic criteria in the neurology chapter (Chapter 13) is advisable. The physician should decide whether evaluation by the spine or neurology chapter criteria is most appropriate.

Table 15-15 Determining Impairment Due to Sensory Loss

a. Classification		
Grade	**Description of Sensory Deficit**	**% Sensory Deficit**
5	No loss of sensibility, abnormal sensation, or pain	0
4	Distorted superficial tactile sensibility (diminished light touch), with or without minimal abnormal sensations or pain, that is forgotten during activity	1-25
3	Distorted superficial tactile sensibility (diminished light touch and two-point discrimination), with some abnormal sensations or slight pain, that interferes with some activities	26-60
2	Decreased superficial cutaneous pain and tactile sensibility (decreased protective sensibility), with abnormal sensations or moderate pain, that may prevent some activities	61-80
1	Deep cutaneous pain sensibility present; absent superficial pain and tactile sensibility (absent protective sensibility), with abnormal sensations or severe pain, that prevents most activity	81-99
0	Absent sensibility, abnormal sensations, or severe pain that prevents all activity	100

b. Procedure	
1.	Identify the area of involvement using the dermatome charts (Figures 15-1 and 15-2).
2.	Identify the nerve(s) that innervate the area(s) (Table 16-12 and Figure 16-48).
3.	Grade the severity of the sensory deficit or pain according to the classification above.
4.	Find the maximum impairment of the extremity(ies) due to sensory deficit or pain for each: spinal nerves (Table 15-8) and brachial plexus (Table 16-14).
5.	Multiply the severity of the sensory deficit by the maximum impairment value to obtain the extremity impairment for each spinal nerve involved.

Table 15-16 Determining Impairment Due to Loss of Power and Motor Deficits

a. Classification		
Grade	**Description of Muscle Function**	**% Motor Deficit**
5	Active movement against gravity with full resistance	0
4	Active movement against gravity with some resistance	1–25
3	Active movement against gravity only, without resistance	26–50
2	Active movement with gravity eliminated	51–75
1	Slight contraction and no movement	76–99
0	No contraction	100

b. Procedure	
1.	Identify the motion involved, such as flexion, extension, etc.
2.	Identify the muscle(s) performing the motion and the spinal nerve(s) involved.
3.	Grade the severity of motor deficit of individual muscles according to the classification given above.
4.	Find the maximum impairment of the extremity due to motor deficit for each spinal nerve structure involved (Tables 15-18, 16-11, 16-13, and 17-37).
5.	Multiply the severity of the motor deficit by the maximum impairment value to obtain the extremity impairment for each spinal nerve involved.

* Adapted from Medical Research Council.[16]

Table 15-17 Unilateral Spinal Nerve Root Impairment Affecting the Upper Extremity*

Nerve Root Impaired	Maximum % Loss of Function Due to Sensory Deficit or Pain	Maximum % Loss of Function Due to Strength
C5	5	30
C6	8	35
C7	5	35
C8	5	45
T1	5	20

* For description of the process of determining impairment percent, see text.

Table 15-18 Unilateral Spinal Nerve Root Impairment Affecting the Lower Extremity*

Nerve Root Impaired	Maximum % Loss of Function Due to Sensory Deficit or Pain	Maximum % Loss of Function Due to Strength
L3	5	20
L4	5	34
L5	5	37
S1	5	20

* For description of the process of determining impairment percent, see text.

15.12a Examples Using the ROM Method

Example 15-22
23% Impairment Due to Herniated Disk With Radiculopathy

Subject: 55-year-old man.

History: Developed low back pain and right sciatica after lifting furniture at home. A herniated lumbar disk was treated surgically, with near complete relief of pain. About 15 months ago postoperatively, he reinjured his lumbar spine while lifting on the job. An MRI showed a recurrent herniated disk at the same level and side as before. He underwent a second diskectomy, but this time was unrelieved of pain.

Current Symptoms: Back and unilateral, radiating right leg pain, unchanged for many months.

Physical Exam: Healed scar on the back. Straight leg raising caused pain along the lateral leg and foot at 30°. The right Achilles reflex was absent. Numbness in the right S1 nerve root distribution range of motion and straight-leg-raising testing using the double-inclinometer technique resulted in the following measurements: true lumbar extension 20°; true lumbar flexion 30°; left lateral flexion 25°; right lateral flexion 20°.

The sensory changes in S1 nerve distribution were judged to be grade 4 according to Table 15-15, and weakness in the S1-innervated muscles was judged to be grade 4 according to Table 15-16.

Clinical Studies: MRI after the second injury: recurrent herniated disk. Repeat MRI with gadolinium after surgery and failure to improve: only perineural scarring. Repeat routine x-rays: slight disk space narrowing at the involved level.

Diagnosis: Recurrent herniated disk with radiculopathy.

Impairment Rating: 23% impairment of the whole person.

Comment: Individual has a 12% whole person impairment according to Table 15-7, 10% due to "surgically treated disk lesion with residual, medically documented pain and rigidity," added to 2% for the second operation. He has an impairment of 2% impairment due to loss of lumbar extension and 4% due to loss of flexion, with at least 45° of sacral (hip) motion (Table 15-8) and 6% loss due to extension and flexion. He has 0% impairment due to loss of left lateral lumbar flexion, 1% loss of right lateral flexion (Table 15-9), and 1% loss of lateral movement. He therefore has 7% impairment due to loss of lumbar motion. From Table 15-15 we see that he has a grade 4 sensory loss of S1. Multiplying 25% (the maximum percentage in this case) by the 5% for maximum loss of S1 sensation from Table 15-18 results in a rating of 1% due to sensory loss. We also see that he has a grade 4 motor loss according to Table 15-16. Multiplying 25% (the maximum in this case) by the 20% from Table 15-18 for S1 motor loss results in 5% impairment due to motor loss of S1. Combining the 1% for sensory loss and the 5% for motor loss results in a 6% impairment due to neurologic loss. Using the Combined Values Chart to combine the impairment from Table 15-7, (12%) with the impairments due to loss of motion (7%) and neurologic involvement (6%) results in a whole person impairment of 23%. In some cases, the physician may be asked to apportion the findings. One approach is to subtract 10% from the latest impairment rating due to the first injury, assuming it was a DRE III without ROM data after the first operation and the radiculopathy had resolved after the first surgery.

Example 15-23
7% Impairment Due to Ankylosing Spondylitis

Subject: 56-year-old man.

History: Individual with known ankylosing spondylitis has become unable to work because of pain and is considering retirement, depending on his impairment rating.

Current Symptoms: Moderate pain; cannot straighten up completely.

Physical Exam: Measurement of the motion and ankylosis in the thoracic spine demonstrates an angle of minimum kyphosis of 60°. With maximum flexion, T1 readings of 35°, 45°, and 55° are recorded, which are matched with T12 flexion angles of 25°, 30°, and 40°, respectively. The angles of thoracic flexion, which are derived by subtracting the T1 angles from the T12 angles, are 10°, 15°, and 15°. These meet validity criteria. T1 rotation to the right measures 15°, 20°, and 15°. Corresponding T12 rotation angles measure 5°, 10°, and 5°. The measurements are valid, and the left rotation angle is 10°. The right thoracic rotation angles are the same as the right.

Diagnosis: Ankylosing spondylitis.

Impairment Rating: 7% impairment of the whole person.

Comment: According to Table 15-10, the impairment due to ankylosis (angle of minimum kyphosis) of 60° is 5% of the whole person and, considering maximum flexion, the impairment due to abnormal motion of 15° is 2%. The total impairment is the greater of the ankylosis and abnormal motion percentages, in this instance, 5%. The impairment due to loss of right thoracic rotation is, according to Table 15-11, 1%. Impairment due to loss of left thoracic rotation is the same. Adding these impairments results in a whole person impairment of 7%. Because there has been no injury or surgery, the individual does not meet any of the other diagnostic criteria in Table 15-7, and there is no neurologic involvement, the whole person impairment is derived solely from the loss of motion and is 7%. If there was loss of motion in any other spinal region, each region would be rated separately and the ratings combined using the Combined Values Chart (p. 604).

Example 15-24
23% Impairment Due to Compression Fractures

Subject: 54-year-old woman.

History: Fell from a ladder and sustained burst fractures of L2 with loss of height of 55% and L3 with loss of height of 20%. Treated with bracing and the fractures healed. Returned to work as a customer service agent 6 months after the injury.

Current Symptoms: No neurologic findings, but she has back pain after heavy activity.

Physical Exam: Mild tenderness to palpation at the fracture site. Neurologic examination is negative. Straight leg raising is negative. True lumbar extension is 10°, flexion is 30°, and left and right lateral bending are each 10°. There is normal hip motion.

Clinical Studies: Repeat x-rays of the area: healed fractures with persistent loss of height of greater than 50% at L2 and 20% at L3.

Diagnosis: Compression fractures L2 and L3.

Impairment Rating: 23% impairment of the whole person.

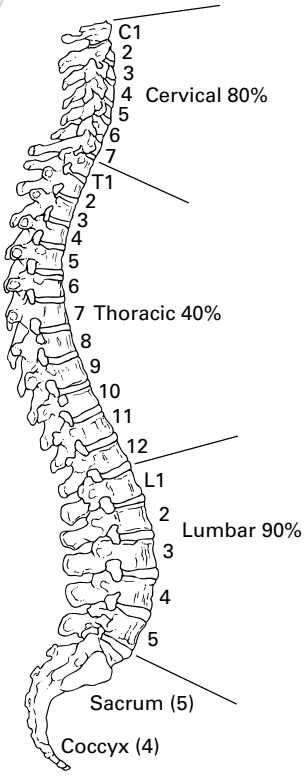
Comment: Injuries at two vertebrae within the same region, with a 55% compression of L2, according to Table 15-7, results in an impairment of 7%. The compression fracture of L3 results in an impairment of 5%, according to Table 15-7. The instructions are to combine these two impairment ratings; doing so results in an impairment rating of 12%.

The woman has true lumbar extension of 10° which, according to Table 15-8, results in an impairment of 5%, a lumbar flexion of 30°, which results in an impairment of 4% (Table 15-8), and left and right lateral bending of 10°, which results in an impairment of 2% for each (Table 15-9). Adding these four impairments due to loss of motion results in an impairment of 13%. Combining the impairment of 12% from Table 15-7 and the 13% from Tables 15-8 and 15-9 results in a whole person impairment of 23%.

15.13 Criteria for Converting Whole Person Impairment to Regional Spine Impairment

In some instances, the evaluator may be asked to express an impairment rating in terms of the involved spine region rather than the whole person. This is done by dividing the whole person impairment estimate by the percent of spine function that has been assigned to that region. Under the DRE method, a whole person estimate being converted to a regional estimate would be divided by 0.35 for the cervical spine, 0.20 for the thoracic spine, and 0.75 for the lumbar and sacral spines. Under the ROM method, a whole person estimate being converted to a regional estimate should be divided by 0.80 for the cervical spine, 0.40 for the thoracic spine, or 0.90 for the lumbosacral spine (Figure 15-19). For example, a 24-year-old female office worker sustained a cervical injury that, after it was healed and stable, resulted in a whole body impairment, estimated by the DRE method, of 20%. Dividing the 20% by 0.35 results in 57% impairment of the cervical spine. An individual with multiple lumbar compression fractures was rated 25% whole body impairment by the ROM method. To obtain an estimate of lumbar spine impairment, the physician should divide the 25% by 0.9, resulting in a 27.7% rounded up to 28% lumbar spine impairment. Any values that exceed 100% are rounded down to 100% regional impairment.

Figure 15-19 Side View of Spinal Column



The whole spine divided into regions indicating the maximum whole person impairment represented by a total impairment of one region of the spine. Lumbar 90%, thoracic 40%, cervical 80%.

15.14 The Pelvis

Criteria for Rating Impairment Due to Pelvic Injury

The pelvis is composed bilaterally of three bones: the ilium, the ischium, and the pubis, forming a ringlike structure. Each ilium is attached to the sacrum via the sacroiliac synchondrosis. The pelvis, including the symphysis pubis, assists in transfer of body weight to the lower extremities. In females, the pelvic structure and function are also of paramount importance in pregnancy and delivery.

Pelvic disorders are evaluated using Table 15-19. When necessary, these disorders may be combined with impairment ratings from either the DRE or ROM methods for spine impairment.

Table 15-19 Whole Person Impairment Due to Selected Disorders of the Pelvis

Disorder	% Impairment of the Whole Person
1. Healed fracture without displacement or residual sign(s)	0
2. Healed fracture with displacement and without residual sign(s) involving:	
a. Single ramus	0
b. Rami, bilateral	0
c. Ilium	0
d. Ischium	0
e. Symphysis pubis, without separation	5
f. Sacrum	5
g. Coccyx	0
3. Healed fracture(s) with displacement, deformity, and residual sign(s) involving:	
a. Single ramus	0
b. Rami, bilateral	5
c. Ilium	2
d. Ischium, displaced 1 inch or more	10
e. Symphysis pubis, displaced or separated	15
f. Sacrum, into sacroiliac joint	10
g. Coccyx, nonunion or excision	5
h. Fracture into acetabulum	Evaluate on basis of restricted motion of hip joint

The impairment estimate for hemipelvectomy is 50% of the whole person (Table 17-32).

Example 15-25
5% Impairment Due to Pelvic Stress Fracture

Subject: 22-year-old man.

History: Military intensive training involving running with a backpack of 40 lbs over extended time and distance. Difficulty standing up because of pain in the pelvis and in the right upper thigh. Pain was enhanced by walking and running. Felt challenged not to report the pain, which he felt while jumping over a boulder 2 weeks prior to the time of the medical exam. The pain was intensified with further running.

Current Symptoms: Pain in the right groin and medial upper thigh aggravated by standing and walking; improved in the supine position.

Physical Exam: Acute tenderness to palpation and pressure on the right pubic bone and the right adductor and hamstrings origin at the inferior ischiopubic junction.

Clinical Studies: Pelvic x-rays: transverse fissure in the upper border of the obturator foramen; there is already a callus development in the area.

Diagnosis: Stress fracture at the right ischiopubic junction.

Impairment Rating: 5% whole person impairment due to delayed union with deformity and residual signs after achieving MMI.

Comment: The callus formation continued and grew, producing a delayed union. He continued to have right groin and medial upper thigh pain, increasing with walking and running, and stabilizing after 9 months. Stress fractures of the pelvis, especially of the inferior branch of the pubic bone, need to be investigated and treated in a timely manner. Delay in investigation and diagnosis may result in massive callus formation and abnormal union, as well as continued pain, especially with standing and running.

15.15 Spine Evaluation Summary

See Table 15-20 for a spine evaluation summary form.

Table 15-20 Spine Evaluation Summary

Name _____ Soc. Sec. No. _____ Date _____

Impairment	Cervical	Thoracic	Lumbar
1. DRE Method (Tables 15-3 through 15-5)			
2. Range-of-Motion Method (and Table 15-8)			
3. Nerve root: Loss of sensation with or without pain Loss of strength			
4. Other (From Section 15.14)			
5. Regional impairment total (combine impairments in each column using the Combined Values Chart, p. 604)			
6. Spine impairment total (combine all regional totals using the Combined Values Chart)			

7. Impairment(s) of other organ systems: for each impairment list condition, page number in *Guides,* and percentage of impairment.

	Impaired System	% Impairment	*Guides* Page Number
a.			
b.			
c.			
d.			
e.			

8. Impairment of the whole person: Use Combined Values Chart to combine spine impairment with the impairment(s) listed in 7 above. If several impairments are listed, combine spine impairments with the larger or largest value, then combine the resulting percentage with any other value(s), until all the listed impairments have been accounted for.

Total whole person impairment: _____

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