Zygomatic, orbital, and frontal sinus fractures

Zygomatic (malar) fractures

These injuries are usually due to a direct blow and are frequently associated with severe eye injuries. 'Tripod fractures' (see Fig. 8.16) involve fractures through the zygomatico-temporal and zygomatico-frontal sutures and the infra-orbital foramen.

Examination Look for flattening of the cheek (often obscured later by swelling), a palpable defect in the infra-orbital margin, infra-orbital nerve damage, diplopia, and subconjunctival haemorrhage (especially if no posterior margin is seen). Isolated fractures of the zygomatic arch may be accompanied by a palpable defect over the arch and limited or painful jaw movement resulting from interference with the normal movement of the coronoid process of the mandible.

Orbital 'blow-out' fractures

This is caused by a direct blow to the globe of the eye (commonly from a squash ball or a shuttlecock), resulting in a fracture of the orbital floor and prolapse of contents into the maxillary sinus.

Examination Check for diplopia due to inferior rectus entrapment (patient cannot look up and medially), enophthalmos, and surgical emphysema. Carefully check the eye itself for injury (hyphaema, retinal detachment, glaucoma, blindness). Record the VA. Test infra-orbital nerve function. Fractures of the floor of the orbit may not be easily visible on X-ray but can often be inferred by the soft tissue mass in the roof of the maxillary sinus ('tear drop' sign), clouding of the sinus, and surgical emphysema.

Management of zygomatic and orbital fractures

- Tell the patient not to blow his/her nose.
- Refer all patients (including those in whom a fracture is clinically suspected but not evident on X-ray) to maxillofacial specialists who will advise regarding prophylactic antibiotics and will arrange further investigation (usually CT scanning) and treatment.
- Involve the ophthalmologists if the eye is also injured.

Patients with orbital emphysema who complain of sudden ↓ in vision may be suffering from a build-up of air under pressure which is compromising retinal blood flow. These patients need emergency decompression.

Retrobulbar haemorrhage

Blunt orbital trauma may be complicated by the formation of retrobulbar haemorrhage. This may result in ↓ vision, limited eye movements, proptosis, and ↑ intra-ocular pressure. This is an ophthalmological emergency requiring lateral canthotomy and cantholysis.

Frontal sinus fractures

Presenting features include supraorbital swelling, tenderness, and crepitus, occasionally with supraorbital nerve anaesthesia. CT scanning will determine whether or not there are fractures of simply the anterior wall or both anterior and posterior sinus walls (± depressed fragments). Give IV antibiotics and refer for admission and observation, which, in the case of depressed fragments, should be to the neurosurgical team.

Major bleeding after facial trauma

Ongoing haemorrhage from the nasal and oral cavities following facial trauma may be difficult to control. Obtain senior expert help and try the following approach:

- Secure the airway with a tracheal tube.
- Reduce fractures into anatomical alignment.
- Use a rigid cervical collar to support the mandible.
- Insert bite blocks into both sides of the mouth, and position these between the posterior molars.
- Tamponade nasal bleeding by placing a 12G Foley catheter into the affected nostril. Insert it into the posterior nasal cavity, then inflate the balloon with 5–7mL of saline. Then pull the catheter slightly more anteriorly, and instil a further 5–7mL of saline, before securing it with a clamp.
- Pad the nose with gauze to ↓ the likelihood of necrosis.
- If there is persistent nasal or oral bleeding, try packing with Vaseline gauze dressings.
- If control of bleeding is not achieved, surgical options include arterial embolization and ligation of the external carotid artery.

Mandibular fractures

Considerable force is required to fracture the mandible, so look for concurrent head or other injuries. The mandible may be fractured at a site distant from the point of impact (eg a fall on the chin may cause condylar fractures). There are often fractures at two or more sites (see Fig. 8.17). The temporomandibular joint may be dislocated or the condyle driven through the temporal bone, causing a skull base fracture.

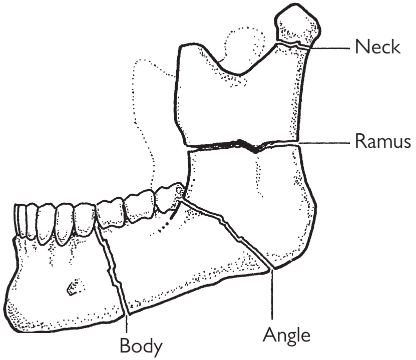


Fig. 8.17 Common fracture sites of the mandible.

Symptoms and signs

The patient usually presents with pain (aggravated by jaw movement or biting). Check for swelling, tenderness, or steps on palpation of the mandible. Look for malocclusion, loose or missing teeth, and intraoral bruising. Numbness of the lower lip indicates injury to the inferior dental nerve where it passes through the ramus of the mandible.

X-rays

Request an orthopantomogram (OPG), which demonstrates most mandibular fractures well (see Fig. 8.18). Temporomandibular joint dislocation and condylar fractures are best shown on condylar views.

Fig. 8.18 Displaced fractured mandible as seen on OPG.

Management

Treat simple undisplaced single fractures not involving the teeth with analgesia, soft diet, prophylactic antibiotics (eg penicillin or co-amoxiclav), tetanus cover, and referral to the maxillofacial outpatient department. Refer displaced or multiple fractures to the on-call specialist.

Refer to the on-call specialist patients with bilateral condyle fractures or single fractures with malocclusion or deviation of the jaw on opening. Advise patients with unilateral asymptomatic fractures to take a soft diet, and arrange outpatient follow-up.

Temporomandibular joint dislocation

This is almost invariably anterior but can be uni- or bilateral. It may be caused by a direct blow to the (often open) jaw or, in patients with lax joint capsule/ligaments, by yawning, eating, dystonic reactions, or intubation. The patient cannot close the mouth; the jaw protrudes anteriorly, and difficulty in swallowing leads to drooling of saliva. The pain is often over the temporal fossa, rather than in the temporomandibular joint itself. Only obtain X-rays if there is a history of direct trauma.

Reduction technique

If seen shortly after dislocation, reduction can usually be achieved simply and without anaesthesia or sedation (see Fig. 8.19). Explain the process to the patient. Sit in front of him/her, and with your gloved thumb(s), protected by a gauze swab, press down and backwards on the lower molar teeth, whilst gently cupping and lifting the chin with the fingers. After reduction, advise the patient to take a soft diet and not to yawn (difficult!) or open the mouth widely for 24hr. Delayed presentations can be associated with muscle spasm, requiring anaesthesia and muscle relaxants.

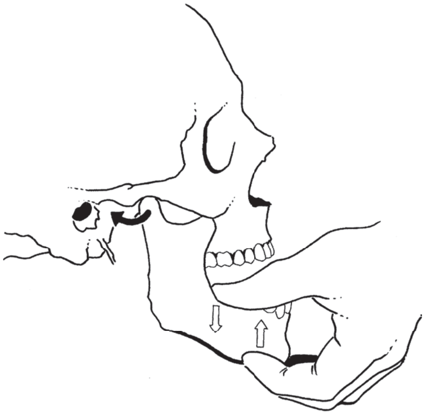


Fig. 8.19 Reduction of dislocated temporomandibular joint.

Penetrating neck trauma

In the UK, neck 'stabbings' and 'slashings' are not uncommon, but gunshot wounds to the neck are rare. The neck is divided into 'zones' when classifying wounds:

- *Zone 1*: extends from the clavicles to the cricoid cartilage.
- *Zone 2*: extends from the cricoid to the angle of the mandible.
- *Zone 3*: is the area from the angle of the mandible to the skull base.

Initial assessment and resuscitation

Give O_2 as required; establish wide-bore venous access (send blood for cross-matching), and resuscitate according to an evaluation of ABCDE. Quickly check for evidence of spinal cord injury. Do not aim to raise the BP too high: a systolic of ~90mmHg is sufficient if the patient is conscious. Look for, and rapidly treat, the following:

- Direct airway injury—may need emergency surgical airway (see ➲ Airway obstruction: surgical airway, p. 336).
- Tension pneumothorax (see ➲ Tension pneumothorax, pp. 338–9).
- Major external haemorrhage—apply pressure to the wound.
- Massive haemothorax (see ➲ Haemothorax, p. 345).

Occasionally the open end of a cut trachea will be seen in extensive neck wounds; secure the airway temporarily by passing an ET or tracheostomy tube into the lumen and securing the tube carefully. Further management depends partially upon the haemodynamic status.

The unstable patient

Haemodynamic instability may be due to tension pneumothorax or massive haemothorax. Persistent major bleeding from a neck wound (usually zone 2) associated with haemodynamic instability is an indication for emergency surgical exploration in theatre. Other indications for exploration include:

- Breach of the platysma (do not probe or explore the wound in the ED).
- Evidence of vascular injury (haemorrhage, expanding haematoma).
- Evidence of surgical emphysema (indicates laryngeal or oesophageal disruption which requires repair).

The stable patient

Many patients are stable and have little evidence of significant injury.

- Provide O_2; secure venous access, and send blood for group and save.
- Monitor SpO_2, pulse, BP, and RR.
- Obtain a CXR (to exclude pneumothorax/haemothorax).
- Provide IV analgesia as required (see ➲ Major trauma: p. 330).
- Establish tetanus status and the need for prophylactic antibiotics (eg cefuroxime 1.5g IV—according to local policy).
- Investigate—consider CT neck. Occasionally four-vessel angiography or duplex USS (to exclude vascular injury) and a contrast swallow/oesophagoscopy (to exclude oesophageal injury) can help (usually zone 1 or 3 injuries).
- Refer to ENT or maxillofacial surgeons for admission, observation, formal wound cleaning, exploration, and closure.
- Carefully document the size, position, and other features of the neck wound, in view of the high medicolegal significance (see ➲ Interpersonal violence—medicolegal implications, p. 411).

Silver trauma

Background

The number of older individuals in the population is ↑ dramatically, and associated with this is a rise in the amount of serious injury in the elderly—which is sometimes referred to as 'silver trauma'.

The 2017 Trauma Audit and Research Network report shows that the most common mechanism of serious injury amongst adults aged >60y is a fall from standing (<2m), which compares with road traffic collisions in adults aged <60y. The elderly are more likely to sustain major injuries after less serious mechanisms, when compared with younger people. Further, the extent of these injuries is less likely to be recognized at presentation.

Outcomes after trauma in the elderly

Falls indoors are an important cause of serious injury in the elderly, with falls down stairs being responsible for the majority of all fall deaths.

Age vs frailty

Evidence suggests that outcomes after trauma in the elderly depend less upon the chronological age of a person than the 'physiological age', which is perhaps most easily expressed in terms of frailty (eg the 'clinical frailty score'—see ➲ Assessing the elderly patient, p. 22). The frail elderly trauma victim has less physiological reserve to cope with serious injury.

Additional considerations in elderly trauma

- The prehospital alerting of potential major trauma from the ambulance service to the ED tends to underestimate injuries in the elderly—so adopt a high index of suspicion of major trauma in older patients who arrive unannounced.
- Initial assessment of the elderly following trauma is also more difficult—patients aged >65y are more likely than younger patients to have catastrophic bleeding, the source of which cannot be identified on primary survey.
- When interpreting initial vital signs, remember that mortality rates in the elderly with a systolic BP of <110mmHg are similar to those in a younger person with a systolic BP of <90mmHg.
- Pre-existing illness can impact dramatically upon presentation (eg prescribed β-blockers preventing tachycardia as a response to hypovolaemia) and upon treatment (eg pre-existing cardiac disease may predispose the patient to heart failure/MI). An initial venous lactate of >2.5mmol/L is a better predictor of mortality after trauma than altered initial vital signs. Think about the person being treated, particularly comorbidities and medication—consider generating a problem list (to include illnesses) following a 'silver survey'.
- Radiation issues are less of a concern in the elderly and injuries are more likely to be concealed, so adopt a lower threshold for CT.
- When performing CT head scans in the elderly after trauma, consider scanning the neck as well—some departments routinely scan down to the bottom of C2, taking into account the fact that 50% of neck fractures in the elderly affect C1 and C2.

Approach to possible spinal injury

Consider spinal injury in every injured patient. Maintain a particularly high index of suspicion and provide spinal immobilization in:

- Major trauma.
- 'Minor' trauma with spinal pain and/or neurological symptoms/signs.
- Altered consciousness after injury.
- A mechanism of injury with a possibility of spinal injury (eg road traffic collision, high fall, diving, and rugby injuries).
- Pre-existing spinal disease (eg rheumatoid arthritis, ankylosing spondylitis, severe osteoarthritis, osteoporosis, steroid therapy), as serious fractures or dislocations may follow apparently minor trauma.

The most common sites of spinal injury are the cervical spine and the thoraco lumbar junction.

Airway management and spinal immobilization

These two aspects demand immediate attention in any patient with possible spinal injury—manage them together. The neck is the most common site of cord injury. If immobilization is not achieved with unstable injuries, it is the site at which most additional cord or nerve root damage can be produced.

- Perform manual immobilization rapidly (without traction), keeping the head and neck in the neutral position, by placing both hands around the neck and interlocking them behind, with the forearms preventing head movement (see Fig. 8.20).
- Maintain manual stabilization/support with sand bags or blocks placed on either side of the head and tape or straps applied to the forehead and chin to prevent rotation. Hard collars are still used by some but remain controversial—evidence of the effectiveness of hard collars is limited and their use is associated with discomfort and other problems. Consider allowing fully conscious patients who present days after a neck injury to lie flat without formal immobilization until assessment/imaging.
- Ensure airway patency and adequate ventilation—hypoxia compromises an injured cord. Initially in an unconscious patient, jaw thrust and suction to the upper airway can be used. Remember that oropharyngeal stimulation can provoke severe bradyarrhythmias. Simple airway adjuncts such as oro- and nasopharyngeal airways often maintain upper airway patency, but sometimes tracheal intubation is required. This must be performed by an individual experienced in advanced anaesthetic techniques (usually RSI, rarely fibre-optic), with an assistant controlling the head/neck to limit cervical spine movement.
- Ventilation can deteriorate due to cord oedema/ischaemia, so look regularly for diaphragmatic breathing (the diaphragm is supplied by C3/4/5) and the use of accessory muscles of respiration. Use pulse oximetry and regular ABG analysis to confirm adequate oxygenation and ventilation. Tracheal intubation and controlled ventilation may be required.
- Patients may have been transported on a scoop stretcher or vacuum mattress—remove these as soon as the primary survey is completed and resuscitation commenced (see Fig. 8.21). Receiving patients onto a specially designed trauma mattress (with carrying handles) can help resuscitation, particularly transferring in and out of the CT scanner.

Suspect spinal injury in patients with ↓ consciousness if there is:

- Flaccid arreflexia.
- ↓ anal tone on PR examination.
- Diaphragmatic breathing.
- An ability to flex (C5/6), but not to extend (C6/7), the elbow.
- Response to painful stimulus above, but not below, the clavicle.
- Hypotension with associated bradycardia.
- Priapism.

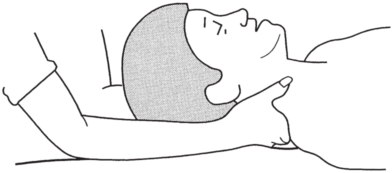


Fig. 8.20 Manual immobilization of the neck.

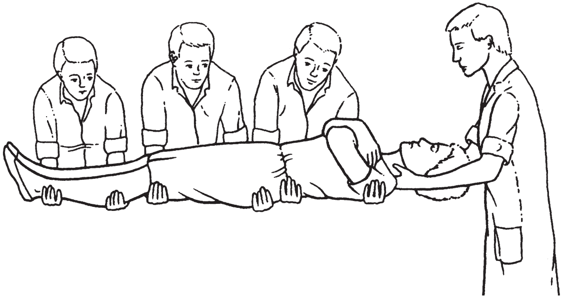


Fig. 8.21 Co-ordinated four-person lift.

Spine and spinal cord injury

Managing the circulation

Monitor ECG and BP. Interruption of the cord sympathetic system causes loss of vasomotor tone, with vasodilatation, ↑ venous pooling, and ↓ BP. Flaccidity and arreflexia, together with the absence of reflex tachycardia or associated (inappropriate) bradycardia, are pointers to this, but before diagnosing 'neurogenic shock', exclude and treat other causes of hypotension (eg blood loss, tension pneumothorax). IV fluid usually corrects relative hypovolaemia, but consider inotropes if ↓ cardiac output persists despite adequate volume replacement and correction of bradycardia by atropine. CVP monitoring in neurogenic shock can help prevent fluid overload.

Other considerations

Insert a urinary catheter to monitor urine output and prevent bladder distension. If there is no craniofacial injury, an NG tube will prevent gastric distension (ileus is common after cord injury) and ↓ the risk of aspiration.

Many patients with spinal cord injury from blunt trauma have other major injuries. Conscious patients can usually describe a sensory level and paralysis, with pain at the level of the vertebral injury. Adopt a high index of suspicion for thoracic/abdominal injury—clinical features may be obscured by sensory or motor deficits from the cord injury itself. Abdominal distension may occur and there may be no signs of peritonism. Consider the need for FAST or CT scan.

Neurological examination

Carefully document the neurological findings, ideally on a specialist chart (eg American Spinal Injury Association chart available at ✆ https://www.asia-spinalinjury.org).

Check light touch and pinprick sensation, proprioception, muscle power, tone, co-ordination, and tendon reflexes. Evidence of distal, motor, or sensory function implies an incomplete lesion, and hence the possibility of recovery. The accuracy of this baseline examination is important, since cephalad progression of abnormalities is a sensitive marker of deterioration and, in the cervical region, may lead to respiratory failure.

Document muscle group strength in upper and lower limbs using the 0–5 grading system (see Table 8.4). It is standard practice to record the most caudal location which has intact (normal) motor and sensory function.

Examine the perineum, and perform a PR examination: look for voluntary contraction and anal tone. An intact bulbocavernosus reflex (squeezing the glans penis/contraction of the bulbocavernosus muscle—S2, 3, 4) and anal cutaneous reflex (scratching peri-anal skin/anal contraction—S4, 5) implies sacral sparing.

Spinal examination

Log roll the patient. The person controlling the head and neck directs movement. Carefully examine for tenderness, step deformity, gibbus, widening of interspinous gaps, and prominence of spinous processes. There may not be overlying tenderness with vertebral body fractures. Remove any debris from under the patient. Keep the patient covered and warm, as ↓ sympathetic vasomotor tone can ↑ the risk of hypothermia.

Table 8.4 Grading muscle strength

Grading of muscle power	
0	Total paralysis
1	Palpable or visible contraction
2	Movement with gravity eliminated
3	Movement against gravity
4	Weaker than usual
5	Normal strength
Muscles supplied by various nerve roots	
C5	Shoulder abductor (deltoid)
C6	Wrist extensors (extensor carpi radialis)
C7	Elbow extensor (triceps)
C8	Middle finger flexor (flexor digitorum profundus)
T1	Little finger abductor (abductor digiti minimi)
L2	Hip flexors (iliopsoas)
L3	Knee extensors (quadriceps)
L4	Ankle dorsiflexors (tibialis anterior)
L5	Big toe extensor (extensor hallucis longus)
S1	Ankle plantar flexors (soleus, gastrocnemius)

Incomplete cord injury patterns

There are several recognized patterns of incomplete spinal cord injury. Although the resultant physical signs can be predicted from a detailed knowledge of neuroanatomy, bear in mind that some patients present with an atypical injury, and therefore an atypical pattern of injury.

Anterior cord syndrome Loss of power and pain sensation below the injury, with preservation of touch and proprioception.

Posterior cord syndrome Loss of sensation, but power preserved.

Brown-Séquard syndrome Hemisection of the cord, producing ipsilateral paralysis and sensory loss below the injury, with contralateral loss of pain and temperature. This syndrome occurs more frequently after a penetrating injury than after a closed injury.

Central cervical cord syndrome Typically seen in elderly patients following extension injuries to the neck, with degenerative changes being the only X-ray or CT abnormality. It is characterized by incomplete tetraparesis, affecting the upper limbs more than the lower limbs (as nerves supplying the upper limbs lie more centrally within the cord). Sensory deficits are variable.

Spinal cord injury without radiographic abnormality

Some children with spinal cord injury have no X-ray or CT abnormality (MRI may help). The extent of both neurological deficit and recovery varies. Adults may have spinal cord injury due to traumatic herniation of an intervertebral disc, epidural haematoma, or ligamentous instability.

Spine and spinal cord injury: imaging

X-rays

For indications for cervical spine X-rays, see ➔ Soft tissue neck injuries, pp. 476–7. Note that spinal cord injury can occur without X-ray (or CT) abnormality. This may be due to ↑ soft tissue elasticity, allowing excessive movement (children), or cord compression from disc prolapse (younger patients), or vascular involvement or spondylosis (older patients).

Cervical spine Request *AP, lateral* (must show C7/T1 junction), and *open-mouth odontoid peg views* if CT of the cervical spine is not indicated. Displacement (subluxation/dislocation) and fractures of vertebral bodies, spinous processes, and the peg are best seen on lateral view. Unifacet dislocation causes anterior displacement ≤50% of the AP diameter of the vertebral body. Displacement >50% suggests bilateral facet dislocation. Look for swelling of prevertebral soft tissues.
AP views show injuries to the pedicles, facets, and lateral masses.
Open-mouth odontoid views usually demonstrate peg fractures.

Thoracolumbar spine Standard views are AP and lateral. In the thoracic region, overlapping structures may make interpretation difficult and necessitate other imaging. If X-rays are of diagnostic quality, visualization of compression or burst fractures and displacement is not difficult, but these have little relation to the degree of cord injury.

Assessment of spinal X-rays

Interpreting spinal X-rays can be difficult. If in any doubt, get senior expert help. A systematic approach helps to prevent injuries from being missed:

- Check alignment of the vertebrae. The spine should be straight or follow gentle curves and should not exhibit any 'steps'. On the lateral X-ray, assess the alignment by checking in turn: anterior vertebral border, posterior vertebral border, posterior facets, anterior border of spinous processes, and posterior border of spinous processes. Look also at interspinal distances.
- Check alignment on the AP film by following the spinous processes and the tips of the transverse processes (see Fig. 8.22). Look for rotational deformity and asymmetry.
- Assess the integrity of each spinal vertebra, including the vertebral bodies, laminae, and pedicles.
- Be vigilant in assessing the odontoid peg view (see Fig. 8.22), looking for asymmetry/displacement of the lateral masses of C1. Distinguish fractures (limited to the bone area) from overlying soft tissue shadows (extend beyond the area of the bone). Note that the atlanto-odontoid distance should be ≤3mm in adults and ≤5mm in children.
- Look for indirect evidence of significant spinal injury (↑ prevertebral space). The normal soft tissue prevertebral thickness at the anteroinferior border of C3 (ie the distance between the pharynx and the vertebral body) is <0.5cm.

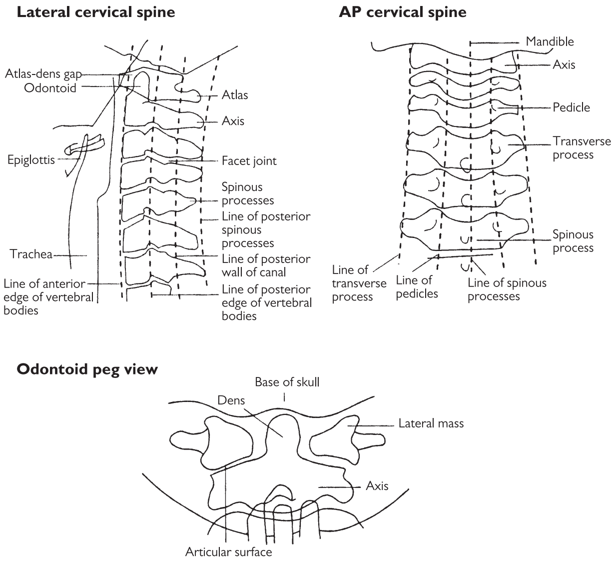


Fig. 8.22 Interpretation of spinal X-rays.

CT and MRI

CT delineates bony abnormalities and the extent of spinal canal encroachment. CT of the cervical spine (base of the skull to T4 level) is indicated for patients requiring CT brain for significant head injury or as part of a 'pan-scan' for multiple trauma (see SIGN and NICE guidelines). CT or MRI are useful for patients in whom there is clinical suspicion of injury (persistent pain, positive neurology) despite normal X-rays. CT is the first-line investigation of older patients (>65y) with suspected spinal injury, as X-rays are likely to be hard to interpret due to degenerative changes.

Further treatment

Immobilize cervical injuries using a firm, well-fitting cervical collar (eg Philadelphia or Miami J), pending advice from the specialist spinal team. Skeletal traction using Gardner–Wells calipers or halo devices and pulley/weight systems may be undertaken by spinal specialists to reduce fracture–dislocations, improve spinal alignment, and decompress the cord.

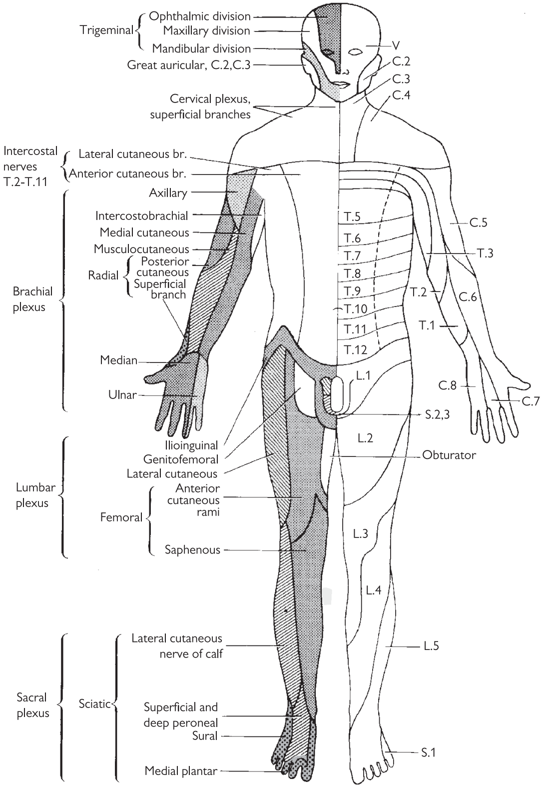
Stable thoracolumbar fractures usually respond to analgesia and rest. If in doubt, discuss with the spinal team, as unstable injuries may be surgically fixed.

With penetrating injuries, if the object is still in place, arrange removal in theatre where the spinal cord/canal injury can be directly seen.

Dermatomes

Dermatomes front

(See Fig. 8.23.)



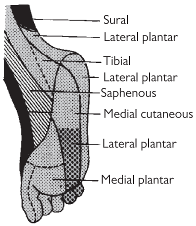


Fig. 8.23 Dermatomes: front.

Dermatomes back

(See Fig. 8.24.)

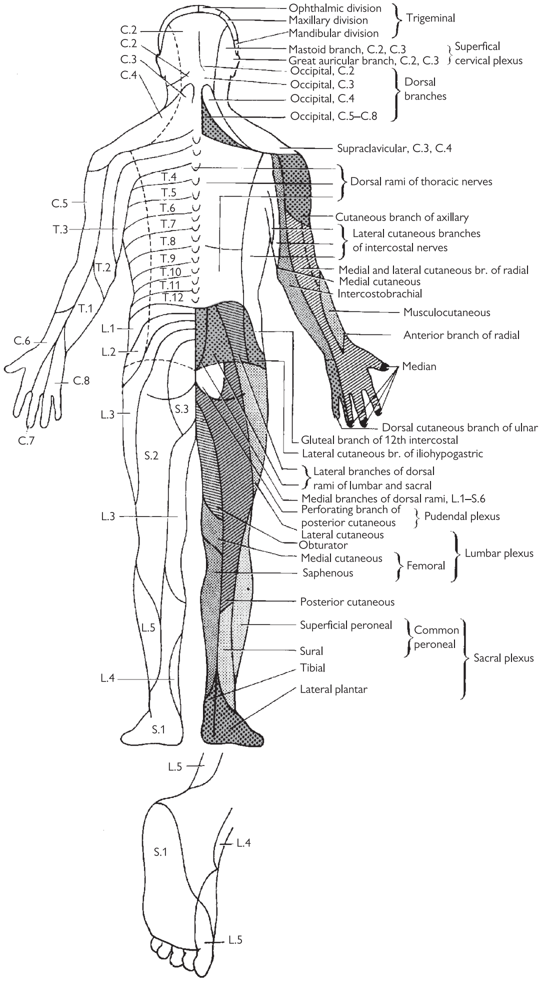


Fig. 8.24 Dermatomes: back.

Gunshot injuries

In the UK, inform the police as soon as possible whenever a patient presents with a gunshot wound. Wounds produced by bullets/missiles are determined by kinetic energy (KE) transfer, missile flight characteristics, and the tissue injured.

Kinetic energy transfer

The KE of a missile is directly proportional to its mass and the square of its velocity (KE = $\frac{1}{2}mv^2$). Thus, tissue injury depends more upon the bullet's velocity than its mass. At velocities > speed of sound, the rate of dissipation of KE becomes proportional to the velocity^3 or even higher powers. Bullets travelling at >1000ft/s (300m/s) are 'high velocity'.

The tissue itself

Tissue density affects a missile and the energy dissipation and tissue destruction. Bone involvement may cause additional retardation, whilst bony fragments cause secondary injuries.

Cavitation

High-velocity bullets transmit energy to the tissues, compressing and accelerating them at right angles away from the track. This leads to cavity formation around the track. Over a few micro-seconds, the cavity enlarges and then collapses. Tissue elasticity perpetuates a process of cavity reformation and collapse, with rapidly ↓ amplitude of oscillations until all KE is expended. This causes highly destructive stretching, tearing, and shearing of tissues, causing injury many times the size of the bullet. Since the pressure in the cavity is sub-atmospheric, debris and organisms are sucked in.

Clinical aspects

Follow standard principles to manage major trauma. Specific aspects are:

- Consider staff safety—involve the police and check the patient for weapons.
- The magnitude of the external wounds may bear little relationship to the severity of internal injury. Remove the patient's clothes (police evidence) and examine the entire body for entrance/exit wounds that are often missed in hairy areas (eg scalp, axillae, and perineum).
- Patients are often young and fit—signs of hypovolaemia may be delayed.
- Chest injuries are commonly associated with pneumothorax (see ➲ Traumatic pneumothorax, p. 344). PEA cardiac arrest should prompt rapid exclusion of tension pneumothorax, then immediate thoracotomy to relieve cardiac tamponade (see ➲ Thoracotomy for cardiac arrest, p. 353).
- Abdominal wounds are associated with a high incidence of internal injury and require laparotomy and antibiotic cover.
- Gunshot wounds are prone to anaerobic infection (especially tetanus and gas gangrene)—clothing/fragments spread widely through tissues distant from the wound track. Extensive surgical debridement (wide excision/fasciotomy) is often required to remove devitalized tissue and foreign material. All high-velocity injuries need delayed primary closure with grafting or suture at 3–5 days.
- Ensure tetanus cover and give prophylactic antibiotics.
- X-ray (AP + lateral) one body region above and one body region below any wound, as well as the region involved, to look for metallic FBs.

Blast injuries

These may follow explosions involving domestic gas, industrial sites (eg mines/mills), or bombs. Several injurious mechanisms may coexist.

Blast wave (primary blast injury)

This is an extremely short-lived pressure wave (lasting a few milliseconds only) which expands outwards from the explosive focus. It is produced by intense compression of air at the interface of rapidly expanding hot gases. The effects can be dramatically aggravated and reinforced by reflection from solid surfaces such as buildings. Blast wave injuries are caused by three mechanisms:

- Disruption at air/tissue interfaces (especially lungs and ears, producing blast lung and tympanic membrane rupture, respectively).
- Shearing injuries at tissue/tissue interfaces, causing subserous and submucosal haemorrhage.
- Implosion of gas-filled organs, leading to perforation of the GI tract and cerebral or coronary air embolism.

Blast winds These are fast-moving columns of air that follow the initial blast wave. Their destructive force can be immense, leading to traumatic amputation or even complete dismemberment. Blast winds also carry debris (masonry, glass, etc.), which act as secondary missiles causing fragmentation injuries.

Fragmentation injuries Objects from a bomb (eg nails, casing, nuts, and bolts) or flying debris (masonry, wood, glass) cause lacerations or penetrating injuries. This is classified as *secondary blast injury*.

Flash burns These are usually superficial, affecting exposed skin in those close to the explosion. Smoke inhalation may also occur.

Tertiary blast injuries These result from individuals being thrown by the blast wind, often causing severe multiple injuries.

Quaternary blast injuries These include all explosion-related injuries or illnesses not due to primary, secondary, or tertiary mechanisms listed above.

Psychological The psychological effects of blast injury are often severe, comprising acute fear, anxiety, and the potential for chronic sequelae.

General aspects of treatment

The principles of blast injury treatment are the same as those of other causes of major trauma (see ➲ Major trauma: treatment principles, p. 330).

Clinical features in blast injuries may be delayed, in terms of both onset and development of clinical signs. This particularly relates to lung and intra-abdominal complications; therefore, observe all patients for at least 48hr.

Search for pneumothorax (may be tension), respiratory failure/ARDS, peritonitis, abnormal neurological signs (suggesting air embolism), eardrum perforation, and anosmia (direct olfactory nerve damage). Note that ventilation of patients with blast injuries is a highly specialized area, with potential risks of producing tension pneumothoraces and air embolism.

Ensure all the patient's clothes, belongings, and any missile fragments are carefully retained, bagged, labelled, and kept secure until given to the police.

Burns: assessment

Types of burns

- Thermal.
- Chemical.
- Electrical (see ➲ Electrical injuries, pp. 276–7).
- Radiation (see ➲ Radiation incidents, pp. 278–9).

History

Determine the circumstances resulting in the burn to appreciate the nature of the insult and potential risks. Consider the following questions:

- Was there an explosion? (risk of blast injuries)
- Was the fire in an enclosed space? (CO poisoning, smoke inhalation)
- What was the burning material? (Burning plastics release cyanide.)
- When was the patient removed from the fire?
- How long was the patient exposed to fire and smoke?
- Was there a history of loss of consciousness?
- Did the patient fall or jump to escape the fire? (Look for other injuries.)
- What is the patient's past medical history and tetanus status?

Initial assessment

This proceeds with resuscitation. *Check*: Airway, Breathing, and Circulation. Particular problems associated with burns are:

- *Airway burns*: suggested by hoarseness, stridor, dysphagia, facial and mouth burns, singeing of nasal hair, soot in nostrils or on palate.
- *Spinal injury*: particularly seen with blast injuries and in those who have jumped from buildings to escape fire.
- *Breathing problems*: contracting full-thickness circumferential burns ('eschar') of the chest wall may restrict chest movement.
- *Circulatory problems*: hypovolaemic shock is a feature of severe burns and may also result from other associated injuries.

Assessing extent

See Mersey burns app, available at https://merseyburns.com

Estimation of the percentage of body surface area burnt is difficult for non-experts. Use Lund and Browder charts appropriate for the age of the patient (see Table 8.5 and Fig. 8.25). The palmar surface of the patient's palm (not including the fingers) represents ~0.75% of body surface area. Do not include simple erythema in calculating the burn percentage.

Assessing depth

Burn depth varies with the temperature and duration of heat applied.

Superficial (first- and second-degree) burns Range from minor erythema (first-degree) through painful erythema with blistering to deep partial-thickness (second-degree) burns, which do not blanch on pressure.

Full-thickness (third-degree) burns May be white, brown, or black and look 'leathery'. They do not blister and have no sensation.

On the day of injury, it may be difficult to distinguish deep superficial (second-degree) burns from full-thickness (third-degree) burns, but correctly making this distinction does not alter the initial management.

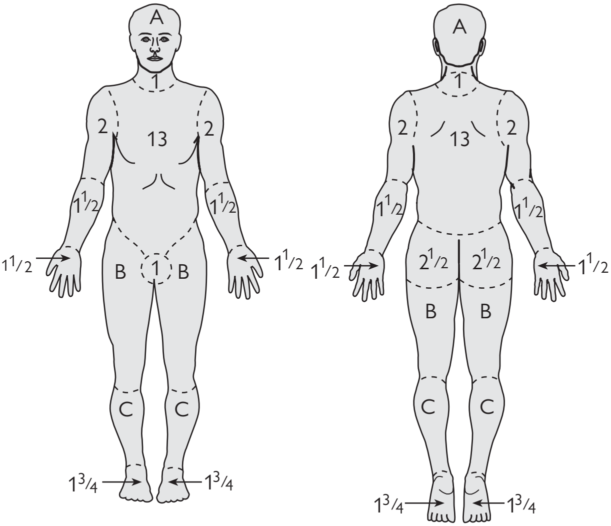


Fig. 8.25 Assessing extent of burns—Lund and Browder charts.

Table 8.5 Relative percentage of area affected by growth (age in years)

	0	1	5	10	15	Adult
A: half of head	$9^1/_2$	$8^1/_2$	$6^1/_2$	$5^1/_2$	$4^1/_2$	$3^1/_2$
B: half of thigh	$2^3/_4$	$3^1/_4$	4	$4^1/_2$	$4^1/_2$	$4^3/_4$
C: half of leg	$2^1/_2$	$2^1/_2$	$2^3/_4$	3	$3^1/_4$	$3^1/_2$

Adults—rule of 9s:	Head	= 9%
	Each arm	= 9%
	Each leg	= 18%
	Front of trunk	= 18%
	Back of trunk	= 18%
	Perineum	= 1%
Infants—rule of 5s:	Head	= 20%
	Each arm	= 10%
	Each leg	= 20%
	Front of trunk	= 10%
	Back of trunk	= 10%

Major burns: resuscitation

Prehospital first aid measures

- Ensure rescuer safety first—be guided by the fire crew.
- Remove the patient from the burning environment. If clothes are smouldering, apply cold water and remove them, unless adherent.
- Provide high-flow O_2. Cover burns in clean sheets.

Airway and cervical spine protection

- Treat airway obstruction (see ➔ Major trauma: treatment principles, p. 330).
- Continue O_2 and immobilize the neck if there is any possibility of spinal injury—cervical spine imaging will be required subsequently.
- If there is any evidence of impending airway obstruction (stridor, oropharyngeal swelling—see ➔ Inhalation injury, pp. 402–3), call immediately for senior ED help and a senior anaesthetist. Urgent GA and tracheal intubation may be life-saving. Use uncut ET tubes to allow for swelling of lips and face.

Analgesia

- Obtain IV access with two large peripheral cannulae.
- Send blood: cross-matching, FBC, COHb, U&E, glucose, and coagulation.
- Provide analgesia (IV morphine titrated according to response).
- Provide an antiemetic (eg IV cyclizine 50mg).

Fluid resuscitation

(See the Mersey burns app, available at https://merseyburns.com)

- Give IV fluids. Start with isotonic crystalloid (eg 0.9% saline) at 2–4mL of crystalloid per kilogram body weight per percentage body surface area burnt, over the first 24hr following injury. Give half of this volume in the first 8hr.
- Check pulse, BP, and RR every 10–15min initially.
- Insert a urinary catheter and test the urine. Patients with myoglobinuria are at particularly high risk of ARF—reduce this risk by adequate fluid resuscitation. Use urine output to guide fluid therapy.
- Review the rate of IV volume replacement frequently and adjust it according to haemodynamic parameters, in order to maintain a satisfactory urine output (>50mL/hr in adults; 1–2mL/kg/hr in children).
- Some burns units prefer a colloid (eg Gelofusine® or albumin) to form a component of the initial volume replacement—follow local policy.
- Patients with full-thickness burns of a body surface area of >10% may require red cell transfusion, in addition to the above measures.

Breathing

- Check COHb and ABG.
- Circumferential full-thickness chest burns restricting chest movement require escharotomy. Cut the burnt areas down to viable tissue to release the constriction. Cutting diathermy can be helpful to reduce the significant blood loss involved in extensive escharotomy.
- Obtain a CXR.

The burn

- Measure the area of the burn as a percentage of the body surface area.
- Irrigate chemical burns with warmed water (see ➲ Management of smaller burns, pp. 404–5).
- Cover the burn with cling film or dry sterile sheets. Do not apply extensive burns dressings before assessment by a burns specialist.
- Involve a burns specialist at an early stage—in the UK, the National Burn Bed Bureau can help to locate a suitable bed (tel: 01384 679036), but clinicians are advised to liaise initially with their local specialized burns service.
- Ensure tetanus prophylaxis, but avoid 'routine' prophylactic antibiotics.

The burnt patient in cardiac arrest

- Follow standard guidelines.
- Give a large bolus of IV fluid.
- If there is a strong possibility of cyanide poisoning (eg burnt plastic furniture in a house fire), give an appropriate antidote, eg dicobalt edetate (see ➲ Cyanide poisoning, p. 215).

Vascular impairment to limbs and digits

Consider the need for longitudinal escharotomies. These are occasionally needed if ischaemia causes severe pain—get advice from a burns specialist.

Liaison with specialist burns centres

Arrangements for liaison with burns centres vary according to the region. Many have systems in place whereby images can be transferred easily, using modern technology, within the law.

Inhalation injury

The most common inhalation injury is smoke inhalation accompanying burns in house fires. Inhalation injury alone may be fatal, and it ↑ mortality for a given body surface area of burn. Smoke is a complex and unpredictably variable mixture of solid, liquid, and gas constituents.

Common components of inhalation injury

- Direct thermal injury.
- Soot particles cause local injury to the cilia of the respiratory tract and obstruct small airways.
- ~85% of fire deaths are caused by CO (see ➲ Carbon monoxide poisoning, p. 216).
- *Gas products of combustion*: oxides of sulfur, nitrogen, ammonia, chlorine, hydrogen cyanide, phosgene, isocyanates, ketones, and aldehydes are highly irritative and cause laryngospasm. Some react with water in the respiratory tract, producing strong acids which cause bronchospasm, mucosal injury, and oedema.

The nature of the inhaled insult determines the site, severity, and systemic features. The upper respiratory tract can dissipate heat efficiently, so that direct thermal injury to the lower respiratory tract is rare unless steam or other hot vapours are inhaled. In the lower airway, toxic components, such as CO and oxides of sulfur, nitrogen, hydrogen cyanide, and hydrogen chloride, cause direct injury and may act as systemic poisons.

Clinical features

Suspect smoke inhalation if any of the following features are present: exposure to smoke or fire in an enclosed space, confusion or altered/loss of consciousness, oropharyngeal burns, hoarseness/loss of voice, singed nasal hairs, soot in nostrils or sputum, wheeze, dysphagia, drooling or dribbling, and stridor.

Investigations

Peak flow rate Determine this in all patients.

ABG Detection of hypoxia, hypercapnia, and acidosis may be helpful but does not correlate well with the severity of inhalation injury. Note that most pulse oximeters have limited value because of the difficulty in distinguishing between oxyhaemoglobin and COHb.

CXR Usually normal initially; later features of ARDS may develop.

COHb CO poisoning cannot be detected by physical examination, SpO_2, or pO_2. Either arterial or venous COHb can be measured. Clinical features correlate poorly with COHb levels. Use the nomogram shown in Fig. 8.26 to estimate COHb levels at the time of exposure. The management of CO poisoning is covered in ➲ Carbon monoxide poisoning, p. 216.

ECG CO binds to myoglobin three times more avidly than to Hb, and by affecting the myocardium, it may produce arrhythmias, ischaemia, or even MI.

Fibre-optic bronchoscopy, xenon lung scanning, V/Q scans, or lung function testing May be required subsequently to assess lung problems due to inhalational injury.

Management

Signs of upper airway problems (facial burns, stridor, dysphagia, drooling, ↓ consciousness) indicate the need for *early tracheal intubation* by an experienced doctor with appropriate training. Mucosal swelling in the oropharynx and epiglottis can progress rapidly. A surgical airway (➔ Airway obstruction: surgical airway, p. 336) can be difficult due to burnt skin and loss of landmarks. Flexible bronchoscopy may help to assess thermal injury to the airway and help intubation. *Assisted ventilation with PEEP* may be indicated.

Give the highest possible concentration of humidified *O_2*. Hyperbaric O_2 may be indicated for CO poisoning but remains controversial (➔ Carbon monoxide poisoning, p. 216).

If bronchospasm occurs, give *nebulized β2-agonist* (salbutamol 5mg) via an O_2-powered nebulizer. ↑ in microvascular permeability leads to pulmonary oedema 2–3 days after the injury, and pneumonia after 7–14 days. Pulmonary fibrosis is common amongst survivors.

Inadequate IV fluid resuscitation is associated with greater pulmonary oedema. Burnt patients who have smoke inhalation need larger amounts of IV fluids to maintain cardiac and urine output.

Inhalation of hydrogen cyanide from smouldering plastics (eg polyurethane) results in rapid systemic absorption. Measurement of blood cyanide concentration is difficult and takes several hours. *Cyanide poisoning* may be suggested by severe metabolic acidosis, a high lactate level, and an ↑ anion gap. Consider cyanide antidotes (➔ Cyanide poisoning, p. 215), but they are potentially toxic, so do not use blindly. There is no proven benefit from steroid therapy.

Nomogram of decay of COHb with time

This nomogram (see Fig. 8.26) allows back-calculation estimation of the likely peak COHb level. It will considerably under-read for children and patients who received a high prehospital FiO_2.

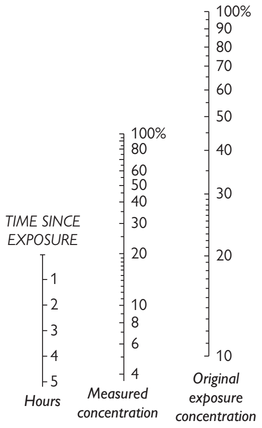


Fig. 8.26 Nomogram of decay of COHb with time.

Management of smaller burns

Assessment

(See ➲ Burns: assessment, p. 398.)

First aid measures

Separate the patient and the burning agent. Cool the affected area with copious quantities of cold water, but beware of hypothermia in infants and young children.

Need for admission

Admit patients with large burns or significant smoke inhalation for IV fluids, resuscitation, and analgesia. In the UK, the National Burn Bed Bureau will search for an appropriate bed (tel: 01384 215576) after discussion with the local burns unit. Also refer for admission burns of suspected NAI origin and patients who would be unable to cope at home (eg an elderly person or if living in difficult social circumstances).

Referral to a burns specialist

Refer patients with the following:

- Airway burns.
- Significant full-thickness burns, especially over joints.
- Burns >10%.
- Significant burns of special areas (hands, face, perineum, feet).

The burn wound

- Leave *full-thickness burns* uncovered, and refer to a specialist.
- Do not de-roof *partial-thickness burns* with blistering—consider simple aspiration. Most can be cleaned and covered with an appropriate dressing (see below).

Hand burns Consider covering with soft paraffin inside a polythene bag or glove sealed at the wrist, changed after 24hr. Simple paraffin/tulle dressings are an alternative—follow local policy. Elevate to minimize swelling. Avoid silver sulfadiazine cream, except on specialist advice.

Facial burns Leave uncovered, or consider application of soft paraffin.

Eye burns Check VA, and refer to a specialist, with prior irrigation if chemical burns (see ➲ Corneal trauma, pp. 554–5).

Perineal and foot burns Burns in these areas should be referred for burns unit admission, as they require specialist nursing and wound care.

Burns dressings

The ideal burns dressing is sterile and non-adherent and encourages wound healing in a moist environment. The diversity of dressings available reflects the fact that this ideal dressing remains elusive. Senior ED nursing staff will advise on local preference and policy. Accumulation of fluid means that many dressings need to be changed at ~48hr—often this is appropriately done at a GP surgery.

Analgesia and tetanus

Unless there is a contraindication and/or if the patient is elderly, NSAID is appropriate and an effective analgesia for many burns which do not require admission. Ensure prophylaxis against tetanus.

Burns in children and non-accidental injury

Unintentional burns are common in children—use the opportunity to offer advice regarding injury prevention. A minority of burns may result from NAI. Suspect NAI (see ➲ Child abuse: head injuries, wounds and burns, p. 760) and seek senior help in the following situations:

- When the explanation does not fit the burn.
- Late presentation.
- Other suspicious injuries.
- Stocking-and-glove distribution scalds (± sparing of the buttocks)—this implies forced immersion in hot water.
- Circular full-thickness burns of ~0.75cm in diameter may represent cigarette burns.

Chemical burns

Initial assessment is notoriously difficult. Alkalis tend to produce more severe burns and can continue to penetrate, even after initial irrigation.

Treat chemical burns with copious irrigation with water, continued for at least 20min in alkali burns. Check skin pH and irrigate until it is normal.

Hydrofluoric acid burns

Hydrofluoric acid is used industrially in a number of processes. Contact with the skin causes particularly severe burns, often with significant tissue damage and severe pain. This is because hydrofluoric acid rapidly crosses lipid membranes and penetrates the tissues deeply where it releases the highly toxic fluoride ion. Fluoride ions may gain access to the circulation and produce a variety of systemic problems by a variety of mechanisms, including interfering with enzyme systems and producing hypocalcaemia by binding to Ca^{2+}.

Manage hydrofluoric acid burns as follows:

- Provide copious lavage to the affected skin, then apply iced water (this provides better pain relief than calcium gluconate gel).
- Call a plastic surgeon at an early stage.
- Check serum Ca^{2+} and Mg^{2+}, and U&E.
- Record an ECG and place on a cardiac monitor.
- Treat hypocalcaemia.

Cement burns

Wet cement or concrete can cause chemical burns due to alkali contact. These are usually partial thickness but may be full thickness. They often occur when wet cement falls into a work boot, but the burn is not initially noticed. Involve a specialist at an early stage.

Phenol burns

Phenol may be absorbed through the skin, resulting in systemic toxicity and renal failure. Get advice from NPIS (see ➲ National Poisons Information Service, pp. 188–9).

Crush syndrome

Background

Crush syndrome covers a spectrum of conditions characterized by skeletal muscle injury (rhabdomyolysis).

Causes include:

- Direct injuries and severe burns causing muscle damage.
- Compartment syndromes—'true' crush injuries produced by entrapment or 'self-crushing' (eg an unconscious individual from drug overdose or alcohol excess lying on a hard surface). A vicious cycle is established where ↑ muscle compartment pressure obstructs blood flow, the muscles become ischaemic and oedematous, and further ↑ compartment pressure and ↓ blood flow lead to more ischaemia and muscle cell death.
- Non-traumatic causes—metabolic disorders (diabetic states, ↓ K^+, ↓ PO_4^{3-}), myxoedema, neuroleptic malignant syndrome, myositis due to infection, or immunological disease.
- Exertional—from undue exertion, grand mal fitting, rave dancing (particularly associated with ecstasy or cocaine use), often complicated by hyperthermia.

Clinical features

Adopt a high index of suspicion. Symptoms depend on the underlying cause, but muscle pain, tenderness, and swelling may not be present at the time of admission. In the lower limbs, the condition is commonly confused with DVT. The classic compartment syndrome with pain on passive muscle stretching and sensory deficits may take several days to develop and can pass unnoticed. The presence of distal pulses does not rule out compartment syndrome.

Investigations

↑ creatine phosphokinase (CPK) levels reflect muscle damage. Check U&E, PO_4^{3-}, Ca^{2+}, and urate. 70% have myoglobinuria and pigmented granular casts (urinary stix tests do not differentiate between Hb and myoglobin). However, absence of myoglobinuria does not exclude rhabdomyolysis, as myoglobin clears rapidly from plasma and its presence in urine depends upon the release rate, the degree of protein binding, GFR, and urine flow. If DIC is suspected, check a coagulation screen.

Treatment

Local problems

Refer urgently to the orthopaedic team if compartment syndromes are suspected. If the difference between intra-compartmental and diastolic pressures is >30mmHg, fasciotomy, excision of dead muscle, and even distal amputation may be required. These procedures may induce life-threatening electrolyte shifts, bleeding, local infection, and later generalized sepsis.

Systemic complications

Severe metabolic complications start after revascularization. Hyperkalaemia may be life-threatening (see ➔ Hyperkalaemia, pp. 170–1). Hypocalcaemia is common initially, but rarely symptomatic.

Acute renal failure

This can be produced by pre-renal, renal, and obstructive elements. Following restoration of circulation or release from entrapment, fluid leaks into damaged areas, ↓ circulating plasma volume. Intracellular muscle contents enter the circulation, and myoglobin and urate crystals can block the renal tubules. This process is aggravated by the ↓ intravascular volume and associated metabolic acidosis. DIC and drugs which inhibit intra-renal homeostatic mechanisms (eg NSAIDs and β-blockers) may also contribute.

Prompt correction of fluid deficits and acidosis (often with CVP monitoring) and establishing a good urinary flow are essential. Alkalinization of the urine may be required—early use of mannitol has been advocated but can cause pulmonary oedema if renal impairment is already present. If renal failure occurs, dialysis may be needed, but prospects for renal recovery are good.

Chapter 9

Wounds, fractures, and orthopaedics

The approach to wounds

Wounds often have medicolegal implications—record notes thoroughly, legibly, and accurately (see ➲ Note keeping, pp. 6–7). Resuscitation is the initial priority for the seriously wounded patient. Stop bleeding by applying direct pressure.

History

Key questions are:

- *What caused the wound?* (Knives/glass may injure deep structures.)
- *Was there a crush component?* (Considerable swelling may ensue.)
- *Where did it occur?* (Contaminated or clean environment?)
- *Was broken glass (or china) involved?* (If so, obtain an X-ray.)
- *When did it occur?* (Old wounds may need delayed closure + antibiotics.)
- *Who caused it?* (Has the patient a safe home to go to?)
- *Is tetanus cover required?* (See ➲ Tetanus prophylaxis, p. 424.)

Examination

Consider and record the following:

- *Length*: preferably measure. If not, use the term 'approximately' in the notes.
- *Site*: use diagrams whenever possible (rubber stamps recommended). Consider taking digital photographs, particularly for open fractures, in order to ↓ the risk of infection by disturbing the wound as little as possible prior to surgery.
- *Orientation*: vertical, horizontal, or oblique.
- *Contamination*: by dirt or other FBs—may be obvious.
- *Infection*: either localized or spreading—is a feature of delayed presentations and is associated in particular with certain specific injuries (eg 'reverse fight bites'—see ➲ Bite wounds, pp. 420–1).
- *Neurological injury*: test and record motor and sensory components of relevant nerves. Be aware that complete nerve transection does not automatically result in complete loss of sensation—some feeling is likely to be preserved (particularly in the hand). Assume that any altered sensation reflects nerve injury.
- *Tendons*: complete division is usually apparent on testing. Partial tendon division is easily missed unless the wound is carefully examined—the tendon may still be capable of performing its usual function. Look in the wound whilst moving the relevant joint, and attempt to re-create the position of the injured part at the time of injury (eg clenched fist) to bring the injured structures into view.
- *Vascular injury*: check for distal pulses.
- *Depth*: wounds not fully penetrating the skin are 'superficial'. Do not try to judge the depth of other wounds before exploration. In some circumstances (eg neck wounds), exploration is not appropriate in the ED.
- *Type of wound*: inspection allows wounds to be described, helping to determine the mechanism of trauma (blunt or sharp injury), and hence the risk of associated injuries. The crucial distinction is whether a wound was caused by a sharp or blunt instrument. If in doubt, avoid any descriptive term and simply call it a 'wound'. This avoids inaccuracy and courtroom embarrassment! Use the terms as described in ➲ Forensic classification of wounds, p. 411.

Forensic classification of wounds

Expert forensic evaluation of injury is outside the remit of the ED specialist, but a simple understanding helps to avoid incorrect use of terminology with associated confusion (and sometimes embarrassment).

Incised wounds Caused by sharp injury (eg knives or broken glass) and characterized by clean-cut edges. These typically include 'stab' wounds (which are deeper than they are wide) and 'slash' wounds (which are longer than they are deep).

Lacerations Caused by blunt injury (eg impact of the scalp against the pavement or an intact glass bottle), the skin is torn, resulting in irregular wound edges. Unlike most incised wounds, tissues adjacent to laceration wound edges are also injured by crushing and will exhibit evidence of bruising.

Puncture wounds Most result from injury with sharp objects, although a blunt object with sufficient force will also penetrate the skin.

Abrasions Commonly known as 'grazes', these result from blunt injury applied tangentially. Abrasions are often ingrained with dirt, with the risk of infection and, in the longer term, unwanted and unsightly skin 'tattooing'. Skin tags visible at one end of the abrasion indicate the edge of skin last in contact with the abrading surface and imply the direction in which the skin was abraded.

Burns See ➔ Burns: assessment, p. 398.

Bruises Bruising reflects blunt force (crush) injury to the blood vessels within the tissues, resulting in tender swelling with discoloration—sometimes localized bleeding collects to form a *haematoma*. The term '*contusion*' is sometimes used as an alternative for bruise—it has no particular special meaning (or value). Record the site, size, colour, and characteristic features of any bruising. It is impossible to determine the exact age of a bruise from its colour. However, yellow colour within a bruise implies (except in the neonate) that it is >18hr old.

Scratches These may comprise either a 'very superficial incision' or a 'long, thin abrasion'—leave the distinction to an expert.

Interpersonal violence—medicolegal implications

Victims of violence frequently attend the ED for treatment of their injuries. Some patients (particularly those who have suffered domestic violence) may not provide an accurate account of how the injuries occurred and may not seek involvement of the police. Classical defence wounds include:

- Isolated ulnar shaft fracture as the arm is raised up for self-protection.
- Incised wounds on the palmar aspects of the palms and fingers sustained in attempts to protect against knife attack.

In cases where the police are involved and where injuries are serious or extensive, the police may arrange photographs and/or examination by a forensic physician (police surgeon) to document injuries. Most ED patients who have suffered violence do not see a forensic physician. Therefore, notes made by ED staff may be important medicolegally.

Further assessment of skin wounds

Investigations

X-ray if there is suspicion of fracture, involvement of joint, penetration of a body cavity, or an FB. Specify if an FB is being sought, to allow appropriate views and exposure. Most metal (except aluminium) and glass objects of >1mm diameter will show up on X-ray. Some objects (eg wood) may not—USS may demonstrate these.

- *Note: X-ray all wounds from glass that fully penetrate the skin.*
- During X-ray, use radio-opaque markers (eg paper clip) taped to the skin to identify the area of concern.
- *Wound swabs* for bacteriology are unhelpful in fresh wounds, but obtain them from older wounds showing signs of infection.

By far, the most important 'investigation' is:

Wound exploration under appropriate anaesthesia

This allows full assessment and thorough cleaning of wounds that extend fully through the skin. Do not explore the following wounds in the ED:

- Stab wounds to the neck, chest, abdomen, or perineum.
- Compound fracture wounds requiring surgery in theatre.
- Wounds over suspected septic joints or infected tendon sheaths.
- Most wounds with obvious neurovascular/tendon injury needing repair.
- Other wounds requiring special expertise (eg eyelids).

Obtain relevant X-rays beforehand. Adequate anaesthesia is essential—in adults, LA (eg 1% plain lidocaine) is often suitable (see ➲ Local anaesthesia, pp. 292–3), but document any sensory loss first (if there is altered sensation, presume nerve injury and refer for formal exploration in theatre). Do not inject LA into the edges of an infected wound—it will not work in that acidic environment and it may spread the infection. GA or topical agents may be the preferred option for treating some wounds in young children.

Inspect wounds for FBs and damage to underlying structures. Most problems with wound exploration relate to bleeding. If it proves difficult to obtain a good view:

- Obtain a good light and an assistant. The assistant retracting on a stitch placed on either side of the middle of the wound allows full exposure.
- Press on any bleeding point for ≥1min, then re-examine. Lidocaine with adrenaline (see ➲ Lidocaine (previously known as 'lignocaine'), p. 293) may help with profusely bleeding scalp wounds.
- If bleeding continues, consider a tourniquet for up to 15min. Consider a sphygmomanometer BP cuff inflated above the systolic pressure (after limb elevation for 1min) on the limbs. Take extreme care if considering using digital tourniquets. Never leave a patient alone with a tourniquet on, lest it is forgotten. Ensure removal of the tourniquet afterwards. Record the time of application and removal.

If these measures fail, refer for specialist exploration in theatre. Do not blindly 'clip' bleeding points with artery forceps, for fear of causing iatrogenic neurovascular injury. Sometimes, small blood vessels in the subcutaneous tissues can be safely ligated using an appropriate absorbable suture (eg 4/0 or 6/0 Vicryl (braided polyglactin) or Dexon).

Puncture wounds and foreign bodies

Puncture wounds

Puncture wounds often involve the foot, after treading on a nail. Examine for neurovascular injury, then obtain an X-ray to look for FBs. If significant foreign material is present or there is associated fracture, tendon injury, or neurovascular deficit, refer for formal exploration and cleaning in theatre under a bloodless field. Otherwise:

- Irrigate and clean other wounds under LA where possible (consider nerve blocks). For wounds to the sole of the foot, this may be impractical. As a compromise, immersing the foot in warm antiseptic (eg povidone iodine solution) for 15min is traditional.
- Apply a dressing and advise review/follow-up with the GP as appropriate.
- Ensure adequate tetanus cover (see ➔ Tetanus prophylaxis, p. 424).
- Prescribe simple analgesia.
- Strongly consider prophylactic oral antibiotic cover (eg co-amoxiclav).

Some puncture wounds may become infected despite treatment. This may be due to retained foreign material in the wound. *Pseudomonas osteitis* is an uncommon, but recognized, complication of puncture wounds to the foot, particularly where a nail has gone through training shoes to cause the wound. Refer infected wounds for formal exploration and irrigation.

Approach to foreign bodies

FBs within soft tissues can cause pain, act as a focus for infection, or migrate and cause problems elsewhere. Try to remove FBs from recent wounds where possible, particularly if lying near a joint (but if the FB is within a joint, refer to orthopaedics for formal exploration and removal). Finding FBs is frequently difficult without a bloodless field and good light. It may be appropriate to leave some FBs such as gunshot deeply embedded in buttock soft tissues (antibiotic cover advised). However, most FBs of any size not removed in the ED warrant specialist consideration.

Late presentation

Patients not infrequently present with symptoms relating to (suspected) FBs (eg thorn) under scabbed or old healed wounds, days or weeks following the injury. USS may help to confirm the presence of an FB and determine its position (marking the skin can help later exploration, which is usually best performed by specialist teams).

Fishhooks

Smaller fishhooks that are relatively superficially embedded can sometimes be pulled back and removed through the entry wound (advancing a hollow needle alongside the hook to cover the barb may help). In other cases, it may be necessary to push a fishhook onwards (under LA), and thus out through the skin—wire cutters can then cut through the hook below the barb and allow release. Wear eye protection when doing this.

Other methods, such as the 'string-yank' technique, carry potential risks of causing additional tissue damage—leave to experienced practitioners.

Note: do not attempt to remove fishhooks from the eyes in the ED—refer to the ophthalmologist.

Wound cleaning and prophylactic antibiotics

Wound cleaning

Thoroughly clean all wounds, irrespective of whether closure is contemplated, in order to ↓ the risk of infection. The standard agent used for wound cleaning is 0.9% (normal) saline, preceded, where appropriate, by washing using tap water—many studies have shown the benefits of thorough tap water irrigation. Aqueous chlorhexidine or 1% cetrimide solutions are sometimes used. Do not use hydrogen peroxide or strong povidone iodine solutions, as these carry other risks, including causing damage to healthy tissue. Wounds ingrained with dirt may respond to pressure saline irrigation (19G needle attached to a 20mL syringe) or may require to be scrubbed with a toothbrush (use goggles to ↓ the chance of conjunctival 'splashback'). Devitalized or grossly contaminated wound edges often need to be trimmed back (debrided), except on the hand or face. If dirt or other foreign material is visible despite these measures, refer to a specialist who may choose to leave the wound open.

Antibiotic prophylaxis

Most wounds do not require prophylactic antibiotics. Thorough cleaning is the best way of preventing infection. After cleaning and closure, consider oral antibiotic prophylaxis for certain wounds—compound fingertip fractures and wounds in those at extra risk (eg valvular heart disease, post-splenectomy). Co-amoxiclav has activity against anaerobes and is appropriate for bites and heavily contaminated or infected wounds—leave these wounds open. Give oral antibiotics for penetrating injuries which cannot be properly cleaned (see ➲ Puncture wounds and foreign bodies, p. 413). Although the scientific basis is debatable, antibiotics are frequently used for wounds >6hr old and complex intraoral wounds and in workers at high risk (gardeners, farmers, fishermen).

There is no evidence of any benefit from the application of topical antibiotics or irrigation using antibiotic solutions.

Tetanus prophylaxis

Consider prophylaxis against tetanus whenever assessing skin wounds (see ➲ Tetanus prophylaxis, p. 424).

Wound closure

Three recognized types of wound closure

Primary closure

- Surgical closure (by whatever physical means) soon after injury.

Secondary closure

- No intervention: heals by granulation (secondary intention).

Delayed primary closure

- Surgical closure 3–5 days after injury.

If there is no underlying injury or FB, aim to treat fresh wounds by primary closure as soon as possible. Accurate opposition of wound edges provides the best cosmetic outcome.

Wounds not usually suitable for primary closure in the ED include:

- Stab wounds to the trunk, perineum, and neck.
- Wounds with associated tendon, joint, or neurovascular involvement.
- Wounds with associated crush injury or significant devitalized tissue/skin loss.
- Other heavily contaminated or infected wounds.
- Most wounds >12hr old (except clean facial wounds).

Methods of closure

Sutures If in doubt, sutures are usually the best option (see ➲ Sutures, p. 416).

Steri-Strips™ Adhesive skin closure strips allow skin edges to be opposed with even distribution of forces. They are inappropriate over joints, but useful for pretibial lacerations where the skin is notoriously thin and sutures are likely to 'cut out'. Before application, make Steri-Strips™ stickier by applying tincture of benzoin to dry skin around the wound. Leave 3–5mm gaps between Steri-Strips™. (See also see ➲ Pretibial lacerations, p. 495.)

Skin tissue glue Particularly useful in children with superficial wounds and scalp wounds. After securing haemostasis, oppose the dried skin edges before applying glue to the wound. Hold the skin edges together for 30–60s to allow the glue to set. Ensure that glue does not enter the wound. Do not use tissue glue near the eyes or to close wounds over joints.

Staples Quick and easy to apply, these are particularly suited to scalp wounds. Staple-removers are required for removal, so consider giving a staple-remover to the patient to take to the nurse at the GP surgery.

Sutures

Sutures (otherwise known as 'stitches' or 'ties') are the traditional and most commonly used method to achieve primary closure. Oppose the skin aiming for slight eversion of the wound edges, using strong non-absorbable inert monofilament suture material attached to curved cutting needles (eg Prolene, polypropylene, or nylon), with knots tied on the outside. Interrupted simple surgical knots tied using instruments are relatively easy and economical of thread and have a low risk of needlestick injuries. Specialized continuous sutures (eg subcuticular) are not appropriate for wounds in the ED. The size of thread used and the time to removal vary according to the site. Use absorbable sutures (eg Vicryl) on the lips and inside the mouth. Absorbable sutures may also be used to close subcutaneous tissues to ↓ the chance of haematoma and infection. Suture choice and time to removal are given in Table 9.1.

Table 9.1 Suture choice and time to removal

Part of body	Suture and size	Time to removal
Scalp	2/0 or 3/0 non-absorbable† glue or staples	7 days
Trunk	3/0 non-absorbable†	10 days
Limbs	4/0 non-absorbable†	10 days
Hands	5/0 non-absorbable	10 days
Face	5/0 or 6/0 non-absorbable	3–5 days*
Lips, tongue, mouth	Absorbable, eg 6/0 Vicryl/Dexon	–

† One size smaller may be appropriate for children.

* Sutures may be replaced with Steri-Strips™ at 3 days.

Key points when suturing

The technique of a basic instrument tie is shown in Fig. 9.1.

- Tie sutures just tight enough for the edges to meet.
- Do not close a wound under tension.
- Handle the skin edges with toothed forceps only.
- Avoid too many deep absorbable sutures.
- Mattress sutures are useful on some deep wounds, but avoid on the hands and face.
- Dispose of sharps as you use them—do not make a collection.
- Use strategic initial sutures to match up obvious points in irregular wounds.
- If a suture does not look right—take it out and try again.
- If it still does not look right—get help!

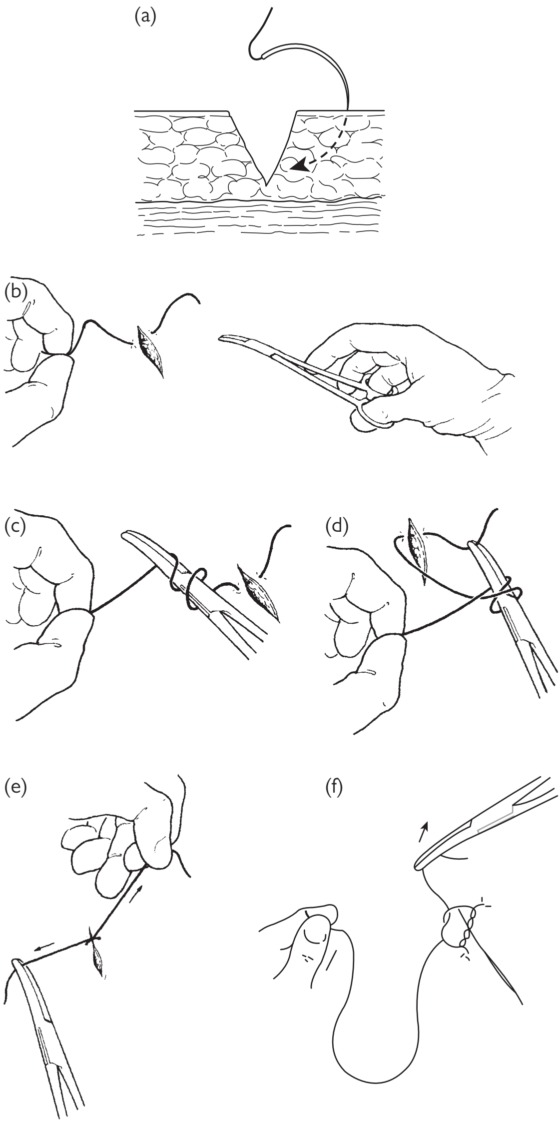


Fig. 9.1 (a) to (f) Basic instrument tie technique.

Wound aftercare

Dressings

A large variety of dressings are available, with little scientific evidence to help choose between them—the choice depends upon personal preference/prejudice and local departmental policy. A dry, non-adherent dressing will protect most wounds from inadvertent contamination in the first few days. Dressings are not usually necessary for facial and scalp wounds. Beware circulatory problems resulting from encircling dressings/bandages applied too tightly to digits or other parts of limbs.

Burns dressings are considered in ➲ Management of smaller burns, pp. 404–5.

General advice

Advise to keep wounds clean and dry for the first few days. Limb wounds require rest and elevation for the first 24hr. After this, restrict movements to avoid undue stress causing the suture line to open up (especially where the wound is over a joint). Warn all patients to return if features of infection develop (redness, ↑ pain, swelling, fever, red streaks up the limb). Approximate times to suture removal are shown in Table 9.1—adjust these according to the situation. For example, sutures over joints are sensibly left for 14 days to avoid dehiscence. Similarly, sutures may need to be left in for longer where wound healing may be delayed (eg diabetes mellitus, the elderly, malnourished, and those on steroids). Local policy will dictate where suture removal occurs (usually at the GP surgery). Ideally, discharge with illustrated instructions about wound care and suture removal. This may particularly help patients with memory impairment or those under the influence of alcohol.

Specific advice

Provide advice about when to return to work. If there is a question of personal safety or safety of the public or work colleagues, advise return to usual duties only once the wound has healed and sutures removed. This particularly applies to food handlers and some machine operators.

Review and delayed primary closure

Arrange review at ~36hr of heavily contaminated wounds, infected wounds not needing admission, and other wounds at particular risk. Evidence of infection are ↑ T°, wound discharge and erythema, ascending lymphangitis, and regional lymphadenopathy. Systemic symptoms or evidence of spreading infection despite oral antibiotics are indications for admission for wound toilet, rest, elevation, and IV antibiotics.

Treat other wounds deemed initially to be at less risk of infection, but not suitable for primary closure, with cleaning, light packing/dressing, and review at 3–5 days. At this stage, delayed primary closure after wound cleaning and debridement under appropriate anaesthesia can be considered.

Do not employ 'loose closure' to manage contaminated wounds. The technique has all the risks of infection combined with a poor cosmetic result.

Infected wounds and cellulitis

Wound infection after injury

Although prompt treatment with cleaning and primary closure will ↓ the risk, any wound may become infected. The risk of infection is ↑ by:

- Contamination (eg bites) and foreign material (including excess sutures).
- Haematoma.
- Devitalized tissue.
- Poor nutrition and ↓ immunity (eg steroid therapy).

Pain is usually the first clue to wound infection. Many soft tissue infections occur without an obvious wound (see ➲ Cellulitis and erysipelas, p. 545).

Examination Indicates the extent of the infection. Erythema and tenderness limited to the area around the wound suggest localized infection. Swelling and fluctuation are evidence of a collection of pus. Remove all sutures, together with pus and devitalized tissue, under appropriate anaesthetic. Send wound swabs for culture. Consider the possibility of a retained FB—X-ray/explore as appropriate. After thorough cleaning, leave the wound open, cover with a dressing, and arrange review with a dressing change in 36hr. Consider the need for antibiotics (eg co-amoxiclav), particularly for cellulitis, the immunocompromised, and patients at particular risk (eg those with prostheses and valvular heart disease).

Consider admission (For rest, elevation, analgesia, wound/blood cultures, and IV antibiotics) in patients with one or more of the following:

- A red line spreading proximally (ascending lymphangitis).
- Regional (sometimes tender) lymphadenopathy.
- Pyrexia >38°C.
- Systemic upset.

Soft tissue crepitus is ominous, suggesting gas-forming organisms (see ➲ Gas gangrene, p. 247).

Infected hand wounds

A particularly common problem is an infected wound on the dorsum of the hand over a metacarpophalangeal joint (MCPJ) after a punch injury. These are often bite wounds, presenting late with infection in the region of the joint. Refer for exploration/washout in theatre and antibiotics (see ➲ Specific bites and stings, pp. 422–3).

Infected facial wounds

Take infected wounds of the cheek very seriously. They pose a significant threat of sepsis spreading intracranially, resulting in papilloedema and ophthalmoplegia due to cavernous sinus thrombosis. Adopt a low threshold for referring for admission and IV antibiotics.

Infected surgical wounds

Infection of a recent surgical wound after a planned procedure is a relatively common complication. In addition to the possible threat to life, wound infection can have disastrous implications as far as the success of the preceding operation is concerned (eg hernias may recur). Contact the team which performed the surgery as soon as possible, to allow the surgeon to treat the complication.

Bite wounds

Bites and infection

Bites cause contaminated puncture wounds, contaminated crush injuries, or both. All carry a high risk of bacterial infection, some also a risk of viral or other infections (eg rabies).

Bacterial infection is particularly likely in:

- Puncture wounds (cat/human bites).
- Hand wounds, wounds >24hr old.
- Wounds in alcoholics, diabetics, or the immunocompromised.

Bacteria responsible include: streptococci, *Staphylococcus aureus, Clostridium tetani, Pasteurella multocida* (cat bites/scratches), *Bacteroides*, and *Eikenella corrodens* (human bites).

Approach

Establish what the biting animal was and how long ago and where the bite occurred. Obtain X-rays if a fracture, joint involvement (look for air), or a radio-opaque FB (tooth) is suspected.

Management of bite wounds

Cleaning

Explore fresh bite wounds under appropriate anaesthesia, and debride and clean thoroughly with 'normal' saline (or by washing using tap water). Refer significant facial wounds and wounds involving tendons or joints to a specialist.

Closure

Cosmetic considerations usually outweigh the risks of infection for most facial wounds, so aim for primary closure. Elsewhere, choose between primary or delayed primary closure—the latter may be preferred in bite wounds affecting the limbs, due to an ↑ risk of infection. Do not close puncture bite wounds that cannot be satisfactorily irrigated.

Antibiotic prophylaxis

Deciding whether or not to employ prophylactic antibiotics for bite wounds can be difficult and is controversial. Many practitioners advocate prophylactic antibiotics for all bite wounds. One approach is to give antibiotics for patients with any of the following:

- Puncture bites.
- Crush injuries with devitalized tissues.
- Bites to the hand, wrist, or genitals.
- Bites that are primarily closed.
- Bites from humans, cats, and rats.
- Bitten patients with immunocompromise (immunosuppressed, diabetes, post-splenectomy, rheumatoid arthritis) or prosthetic joints.

Co-amoxiclav is an appropriate broad-spectrum agent, effective against streptococci, staphylococci, *Pasteurella*, and *Eikenella*. Alternatives for adult patients allergic to penicillin/amoxicillin include doxycycline + metronidazole or (especially if pregnant) ceftriaxone alone. In children, azithromycin + metronidazole may be an option.

Tetanus

Bite wounds are tetanus-prone. Give prophylaxis accordingly (see ➲ Tetanus prophylaxis, p. 424).

Rabies

(Covered fully in ➲ Rabies, p. 257.)

Rabies results after the 'bullet-shaped' RNA rhabdovirus present in the saliva of infected animals is transmitted to humans via a mucous membrane or skin break. After thorough cleaning, refer all patients who might have been in contact with a rabid animal to an infectious diseases specialist. Obtain further help from the Virus Reference Department in London (tel: 0208 327 6017). The long incubation period of the rabies virus (14–90 days) allows successful post-exposure prophylaxis at even a relatively late stage, according to agreed guidelines.

Hepatitis and HIV

Consider the possible risks of hepatitis B, hepatitis C, and HIV in anyone who presents following a human bite, and treat accordingly (see ➲ Needlestick injury, p. 425). Quantifying risks can be difficult, particularly, for example, in 'reverse fight bites' (see ➲ Specific bites and stings, pp. 422–3) where the other person involved may be unknown. If in doubt, take a baseline blood sample for storage (to allow later testing, if necessary) and provide cover against hepatitis B.

Treatment of infected bites

Most bacterial infections occur >24hr after injury and are due to staphylococci or anaerobes. Pain, inflammation, swelling ± regional lymphadenopathy within 24hr suggest *P. multocida* infection. Take wound swabs of all infected wounds, then treat with cleaning, elevation, analgesia, and antibiotics. Oral co-amoxiclav and outpatient review at ~36hr is appropriate for localized wound infection with no systemic symptoms and no suspected underlying joint involvement. Refer patients with spreading infection for IV antibiotics and admission.

Septicaemia is uncommon after bite injury but has been reported with the Gram –ve bacillus *Capnocytophaga canimorsus*, previously known as Dysgonic Fermenter 2 (DF-2). Infection produces severe illness with septicaemia and DIC, often in the immunocompromised (splenectomized individuals, diabetics, or alcoholics). Take wound swabs and blood cultures, then give IV antibiotics and refer.

Prevention of dog bites

Injury prevention measures aimed at preventing children from being bitten include legislation relating to 'dangerous dogs' and education. Children may be taught the following:

- To treat dogs with respect.
- To avoid disturbing a dog that is sleeping, eating, or feeding puppies.
- To avoid shouting or running in the presence of a dog.
- Not to approach or play with unfamiliar dogs.

Specific bites and stings

Human bites and 'fight bites'

Many human bites occur 'in reverse', when an individual punches another in the mouth, causing wounds on the hand over the MCPJs. Underlying joint involvement is common and may progress to septic arthritis, unless treated aggressively with exploration, irrigation, and antibiotics. Refer all patients for this. Consider hepatitis B, hepatitis C, and HIV; give appropriate prophylaxis (see ➲ Needlestick injuries, p. 425), and arrange counselling.

Tick bites

Ticks are recognized vectors of a number of exotic diseases worldwide. In the UK, patients often present with embedded sheep ticks. Remove ticks by gentle traction, with blunt forceps applied as close to the skin as possible. Avoid traditional folklore methods of removal, which may cause the tick to regurgitate, promoting infection. In areas where Lyme disease is endemic (see ➲ Ticks, p. 241), routine antibiotic prophylaxis is not recommended (http://www.nice.org.uk), but there is evidence (in those aged ≥12y) that a single dose of doxycycline 200mg PO may ↓ the risk of developing Lyme.

Insect bites

Minor local reactions are common. Treat with ice packs, rest, elevation, analgesia, and antihistamines (eg chlorphenamine 4mg tds PO or a non-sedating alternative such as loratadine 10mg od PO). Occasionally, insect bites may be complicated by cellulitis and ascending lymphangitis requiring antibiotics (see ➲ Infected wounds and cellulitis, p. 419).

Wasp and honey bee stings

These may cause local reactions or anaphylaxis—treat promptly (see ➲ Anaphylaxis, pp. 44–5). Flick out bee stings left in the skin. Treat local reactions as for insect bites.

Jellyfish stings and fish spines

Most jellyfish in UK coastal waters are relatively harmless. Wash the injured part in sea water or saline, and lift off any remaining tentacles with a towel or stick. Consider applying an ice pack as analgesia. Use of vinegar is no longer recommended.

Fish spines (typically Weever fish) produce a heat-labile toxin, which may be neutralized by immersion in hot water for 30min. Occasionally, tiny parts of the fish spines become embedded and cause long-term irritation. Localizing and removing these tiny FBs is difficult, so refer to an appropriate expert.

Contact with other wild animals

Contact with rats' urine may cause leptospirosis (Weil's disease) ➲ Leptospirosis (Weil's disease, p. 249). Provide prophylactic doxycycline to anyone who presents following an episode of significant exposure (eg immersion in river water or sewage). Unusual bites may pose specific threats, which infectious disease specialists will advise about (eg monkey bites may cause herpes simplex infection—give prophylactic oral aciclovir). Bats may carry rabies (➲ Rabies, p. 257).

Snake bites

The European adder (*Vipera berus*) is the only native venomous snake in the UK. It is grey/brown, with a V-shaped marking behind the head and dark zig-zag markings on the back. Most bites occur in summer. Venom is injected by a pair of fangs. The venom contains enzymes, polypeptides, and other low-molecular weight substances. Only 50% of bites cause envenomation.

Features

Envenomation causes pain and swelling—look for two puncture marks, 1cm apart. Vomiting, abdominal pain, diarrhoea, and hypotension may follow. A small proportion of patients develop severe systemic symptoms within minutes of the bite.

Investigations

Check urine; perform an ECG (check QTc), and take blood for: FBC, U&E, LFTs, coagulation screen, and D-dimer.

Treatment

- Prehospital: rest (and avoid interference with) the bitten part—do not try to 'suck out' fluid or apply tourniquets.
- Clean and expose the wound; give analgesia and IV fluids for hypotension.
- Treat anaphylaxis urgently according to standard guidelines (see ➔ Anaphylaxis, pp. 44–5).
- Ensure tetanus cover. Latest evidence suggests that prophylactic antibiotics are not usually required.
- Obtain specific advice from NPIS (see ➔ National Poisons Information Service, pp. 188–9)—a toxicology specialist will advise regarding the appropriate use/dose of antivenom.
- Use of antivenom does carry some risk but is indicated for anaphylaxis-like reaction to the venom, signs of systemic envenoming (abdominal pain and vomiting), hypotension for >10min, WCC >20 × 10^9/L, ECG abnormalities, elevated CK, metabolic acidosis, pulmonary oedema, spontaneous bleeding, or significant limb swelling (eg past the wrist for bites on the hand or past the ankle for bites on the foot, within 4 hr).
- Observe for least 24hr all patients who have any symptoms after a snake bite.

Tetanus prophylaxis

Spore proliferation and toxin production are likely in heavily contaminated wounds with devitalized tissue (see ➲ Tetanus, p. 246). However, any wound (including a burn) is a risk—always ensure tetanus prevention.

Tetanus immunization programme

Standard active immunization involves an initial course of three IM or deep SC doses of 0.5mL of tetanus toxoid (formalin-inactivated toxin), given at monthly intervals, starting at 2 months of age, followed by booster doses at 4 and 14y. In the UK, combined tetanus/diphtheria/inactivated polio vaccine has replaced the previous tetanus/diphtheria vaccine for adults and adolescents. Inadequate immunity against tetanus is particularly likely in immigrants, the elderly, patients with ↓ immunity, and those who have refused vaccination.

Anti-tetanus prophylaxis (See 🖱 https://www.gov.uk)
Follow the Department of Health guidelines. The need for tetanus immunization after injury depends upon a patient's tetanus immunity status and whether the wound is 'clean' or 'tetanus-prone' or 'high-risk, tetanus-prone': The following are regarded as 'tetanus-prone':
- Puncture wounds in a contaminated environment.
- Certain animal bites (especially non-domestic or farm animals).
- Wounds containing FBs.
- Wounds or burns with systemic sepsis.
- Open fractures.

'High-risk, tetanus-prone' wounds are 'tetanus-prone' wounds plus one of:
- Heavy contamination with soil/manure.
- Wounds/burns with extensive devitalized tissue.
- Wounds/burns requiring surgical intervention that is delayed by >6hr.

Do not give tetanus vaccine if there is a past history of a severe reaction—give tetanus immune globulin (TIG). Pregnancy is not a contraindication to giving tetanus prophylaxis.

Children who are up-to-date and adults who have had booster within 10y
Do not give any immediate vaccine or human TIG. Encourage children to complete a course in future, as planned.

Initial course complete, but last booster >10y ago or children aged 5–10y who had an initial priming course, but no preschool booster
No vaccine is required for clean wounds, but give a reinforcing dose of tetanus vaccine for tetanus-prone wounds. For high-risk, tetanus-prone wounds, give a booster and human TIG (250–500U IM) in a different site.

Has not received an adequate priming course (of ≥3 vaccines or immunization status unknown or uncertain)
Give an immediate reinforcing dose of vaccine for all wounds. For tetanus-prone wounds (whether high risk or not), give a dose of human TIG at a different site.

The TIG dose is usually 250U IM, but give 500U if >24hr have elapsed since the injury or if there is heavy contamination or following burns.

Needlestick injury

Many infective agents have been transferred by needlestick: blastomycosis, brucellosis, cryptococcosis, diphtheria, Ebola fever, gonorrhoea, hepatitis B, hepatitis C, herpes zoster, HIV, leptospirosis, malaria, mycobacteriosis, mycoplasmosis, Rocky Mountain spotted fever, scrub typhus, sporotrichosis, *Staphylococcus aureus, Streptococcus pyogenes*, syphilis, toxoplasmosis, and TB.

In practice, the principal risks are hepatitis B and C and HIV. The risk of acquiring hepatitis B following a needlestick injury from a carrier has been estimated at 2–40%. All hospital workers should be immunized against hepatitis B. The risk of hepatitis C is believed to be 3–10%. In contrast, the risk of acquiring HIV after a needlestick injury with a HIV +ve source is much less (estimated at 0.2–0.5% but may be higher if significant volumes are injected). There is a small (~0.03%) risk of HIV transmission after mucocutaneous exposure (ie exposure of cuts, abrasions, and mucous membranes, including the eye). The (small) risk of acquiring HIV following a needlestick injury from a person with known HIV may be reduced further by post-exposure prophylaxis, but time is of the essence (see ➲ Management below). No proven post-exposure prophylaxis currently exists for hepatitis C. Preventing needlestick injuries and exposure to these viruses is therefore crucial.

Management

- Wash the wound with soap and water.
- Ensure tetanus cover.
- Ensure hepatitis B cover—if not previously immunized, consider hepatitis B immunoglobulin and start an active immunization course (give the first vaccine in the ED, and arrange subsequent doses). If previously immunized, check antibody titres. If satisfactory, take no further action. If low, give a booster vaccine. If very low, both give the immunoglobulin and start a vaccine course. Many local needlestick policies advise obtaining informed consent from the source patient, prior to taking blood to check the hepatitis and HIV status. In practice, the identity of the source patient is not always clear—do not withhold hepatitis B prophylaxis if there is any doubt.
- If the source patient is known to be (or suspected of being) HIV +ve, follow local guidelines and/or refer immediately to an infectious diseases specialist to discuss post-exposure prophylaxis and follow-up. Follow guidance on 🖱 http://www.dh.gov.uk. Current combined prophylaxis therapy is one Truvada® tablet od (comprising 245mg tenofovir + 200mg emtricitabine) + one raltegravir tablet 400mg bd. It is most effective if started within an hour of exposure but may be worth considering up to 72hr. Prophylaxis has side effects, although raltegravir is better tolerated than the previously used Kaletra®. Involve both a health care worker and a local expert in deciding whether or not to start prophylaxis. Either way, advise the patient to use barrier contraception and not to give blood as a donor until subsequent HIV seroconversion has been ruled out.
- Take baseline blood for storing (serology for possible future testing), and in the case of a possible HIV source patient, also take blood for FBC, U&E, LFTs, and amylase.
- If the incident occurred in hospital, report it to occupational health.

How to describe a fracture

Clear, precise, complete descriptions of fractures aid accuracy and save time when referring patients.

System for describing fractures

- State the age of the patient and how the injury occurred.
- If the fracture is open, state this first (and the Gustilo type—see ➲ Open (compound) fractures, pp. 428–9).
- Name the bone (specify right or left and, for the hand, whether dominant).
- Describe the position of the fracture (eg proximal, supracondylar).
- Name the type of fracture (eg simple, spiral, comminuted, crush).
- Mention any intra-articular involvement.
- Describe the deformity (eg displacement, angulation) from the anatomical position.
- State the grade or classification of the fracture (eg Garden IV).
- State the presence of any complications (eg pulse absent, paraesthesiae, tissue loss).
- Other injuries and medical problems.

Example using this system

'A 29y-old ♂ motorcyclist with an open fracture of the left humerus. It is a transverse fracture of the humeral shaft and is Gustilo type I open and minimally displaced with no neurovascular compromise … '

Type of fracture

Simple Single transverse fracture of bone with only two main fragments.

Oblique Single oblique fracture with only two main fragments.

Spiral Seen in long bones as a result of twisting injuries, only two main fragments.

Comminuted Complex fracture resulting in >2 fragments.

Crush Loss of bone volume due to compression.

Wedge Compression to one area of bone resulting in a wedge shape (usually applied to vertebra).

Burst Comminuted compression fracture with scattering of fragments.

Impacted Bone ends driven into each other.

Avulsion Bony attachment of ligament or muscle is pulled off.

Hairline Barely visible lucency with no discernible displacement.

Greenstick Incomplete fracture of immature bone follows angulatory force, with one side of the bone failing in compression, the other side in tension.

Torus/buckle Kinking of the metaphyseal cortex follows axial compression.

Pathological Fracture due to underlying disease (eg osteoporosis, metastasis, Paget's disease).

Stress Certain bones are prone to fracture after repetitive minor injury.

Plastic deformation Deformation beyond the elastic limit, but below the fracture point, results in bending of bone ± microfractures (these are not apparent on X-ray) (see Fig. 9.2).

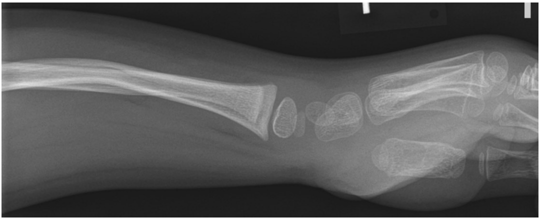


Fig. 9.2 Plastic deformation of radius and ulna shafts in a 5y old.

Fracture–dislocation Fracture adjacent to, or in combination with, a dislocated joint.

Deformity Describe deformity using the terms displacement, angulation, and rotation.

Displacement ('translation') Describe the relative position of two bone ends to each other. Further describe the direction that the distal fragment is displaced from the anatomical position (eg volar, lateral). Also estimate the degree of apposition of the bone ends (eg 50%).

Angulation This is usually described in terms of the position of the point of the angle (eg posterior angulation means that the distal fragment is pointing anteriorly). This can sometimes be confusing. Although a little long-winded, one way to avoid confusion is to describe the direction in which the distal part points, relative to the anatomical position (eg a Colles' fracture may be described as a 'fracture of the distal radius in which the distal fragment points dorsally'). Try to measure the angle on X-ray.

Rotation Describe the degree of rotation from the anatomical position, in terms of the direction (eg external or internal rotation) in which the distal part has moved.

Long bone anatomy

Each long bone has a shaft or diaphysis with an epiphysis at each end. Whilst the bone is growing, these are separated by an epiphyseal growth plate and this narrows down into the bone shaft. The transitional area of bone is the metaphysis. In addition to these landmarks, the femur and humerus have a ball-shaped head, a narrower neck, and, at the lower ends, a widened area consisting of, respectively, the medial and lateral condyles of the femur and the medial and lateral epicondyles of the humerus. Fractures proximal to these areas of the femur and humerus are termed supracondylar. Intercondylar fractures involve the central, distal, and juxta-articular portions. Fractures of the proximal femur between the greater and lesser trochanters are termed intertrochanteric.

Open (compound) fractures

Open (or compound) fractures occur when a fracture is open to the air through a skin wound. They incur a risk of infection and can be associated with gross soft tissue damage, severe haemorrhage, or vascular injury. Treat as orthopaedic emergencies requiring rapid assessment and treatment.

Classification of open injuries

The Gustilo classification of open injuries is as follows:

Type I Open fracture where the wound is <1cm long and appears clean.

Type II Open fracture where the wound is >1cm but is not associated with extensive soft tissue damage, tissue loss, or flap lacerations.

Type IIIA Either an open fracture with adequate soft tissue coverage of bone despite extensive soft tissue damage or flap laceration or any fracture involving high-energy trauma or bone shattering regardless of wound size.

Type IIIB Open fracture with extensive soft tissue loss, periosteal stripping, and exposure of bone.

Type IIIC Compound fracture associated with vascular injury needing repair.

Management

Provide adequate fluid replacement, analgesia, splintage, antibiotics, and tetanus prophylaxis prior to surgical treatment. Rapidly complete the following steps whilst contacting the orthopaedic service:

- Treat life-threatening injuries before limb-threatening injuries. Do not be distracted from initial priorities by dramatic distal limb injuries.
- Control obvious haemorrhage by direct manual pressure whilst commencing IV fluids and/or blood replacement.
- Give analgesia in the form of incremental IV opioids (see ➲ Analgesics: morphine, p. 286).
- Once analgesia is adequate, correct obvious severe deformities with gentle traction and splint. Certain dislocations may require immediate correction. Remove obvious contaminants if possible (eg large lumps of debris or plant matter).
- 'Routine' wound swabs for bacteriological culture are no longer recommended. They do not alter management and are poor predictors of deep infection.
- If available, take digital photographs of the wound (this helps to avoid the need for repeated inspection by different clinicians).
- Irrigate with saline, then cover the wound with a sterile moist dressing (eg saline-soaked pads). Immobilize the limb in a POP backslab. Do not repeatedly inspect the wound, as this greatly ↑ the risk of infection. Once dressed and in POP, leave injuries covered until surgery.
- Give IV antibiotics (eg co-amoxiclav 1.2g or cefuroxime 1.5g according to local policy). Consider adding gentamicin or metronidazole if the wound is grossly contaminated.
- Give tetanus toxoid if indicated, and give human TIG if gross wound contamination is present (see ➲ Tetanus prophylaxis, p. 424).

Record the presence/absence of distal pulses/sensation and recheck frequently.

Limb salvage or amputation

Orthopaedic surgeons often face a difficult decision as to whether or not a limb can be salvaged. Gustilo type IIIC injuries are associated with a high rate of amputation. The Gustilo classification alone is not always an accurate predictor of outcome—other tools have been developed to assist. For example, the Mangled Extremity Severity Score takes into account the extent of skeletal and soft tissue damage, the extent and severity of limb ischaemia, associated shock, and age.

Dislocations (and subluxations)

A dislocation has complete loss of congruity between articular surfaces. A subluxation implies movement of the bones at the joint, but with some parts of the articular surface still in contact. Describe dislocations in terms of the displacement of the distal bone. For example, most shoulder dislocations are 'anterior', with the humeral head lying in front of the glenoid. Aim to reduce dislocations as soon as possible to prevent neurovascular complications, ↓ the risk of recurrence, and ↓ pain. In general, X-ray (to identify the exact dislocation ± associated fracture) before attempting a reduction. Exceptions to this principle are:

- Dislocations associated with considerable neurovascular compromise requiring urgent intervention (eg some ankle fracture–dislocations).
- Uncomplicated patellar dislocations.
- Uncomplicated mandibular dislocations.
- Some patients with (very) recurrent shoulder dislocations where there may be longer-term concerns regarding radiation exposure.
- Some patients with collagen disorders resulting in hypermobility (eg Ehlers–Danlos syndrome) and unusual/recurrent dislocations without significant trauma.
- 'Pulled elbow' in young children (see ➔ Subluxation of the radial head ('pulled elbow'), p. 750).

Use analgesia/sedation/anaesthesia appropriate to the dislocation and the individual circumstances. For example, patellar dislocations often reduce under Entonox®, finger proximal interphalangeal joint (PIPJ) dislocations with LA digital nerve blocks (see Fig. 9.3), and shoulder dislocations with IV analgesia ± sedation, whereas posterior hip dislocations typically require manipulation under GA. Unless there are exceptional circumstances, X-ray after manipulation to confirm adequate reduction and also to check for fractures which may not have been apparent on initial X-rays.

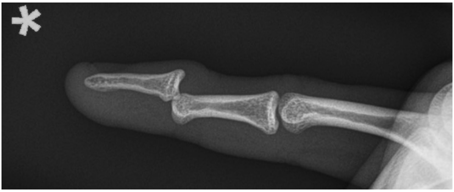


Fig. 9.3 Dorsal dislocation of finger DIPJ.

Casts and their problems

Plaster of Paris (POP)

POP is cheap and easy to use and can be moulded. Usually applied in the form of a bandage or multiply folded as a supporting slab (see Fig. 9.4). Disadvantages are susceptibility to damage (POP rapidly disintegrates if wet) and it takes up to 48hr for larger casts to dry fully after application. Cut slabs to shape prior to use, and apply over wool roll and stockinette. Mould with the palms (not the fingertips) to avoid point indentation of plaster.

Resin (fibreglass) casts

More costly, but lighter and stronger than POP and more resistant to water or other damage. Made of cotton or fibreglass impregnated with resin that hardens after contact with water. Sets in 5–10min, maximally strong after 30min. Most resin casts are more difficult to apply and remove. Being more rigid and harder to mould, there is an ↑ risk of problems from swelling or pressure necrosis. Remove/cover any sharp edges on the cast.

Complications of casts

Give all patients discharged with casts clear written instructions (including a contact phone number) to return if they develop pain or other symptoms in the immobilized limb. Formal cast checks within 24hr are only required if there is particular concern about swelling. Simple swelling or discoloration of fingers or toes usually responds to elevation and simple exercises.

Is the cast too tight?

Act immediately upon suspicion of circulatory compromise from a cast. Look for the 'five Ps': pain, pallor, paraesthesiae, paralysis, and 'perishing cold'. If any of these are present:

- Elevate the limb.
- Cut wool and bandages of the backslab until the skin is visible along the whole length of the limb.
- Split full casts and cut through all layers until the skin is visible along the whole length of the limb.

Any undivided layers will continue to obstruct the circulation until released. If this action fails to completely relieve the symptoms, contact orthopaedic and vascular surgery staff immediately, as angiography and urgent surgical intervention may be required. Note that compartment syndrome may occur in the presence of normal pulses.

Is the cast too loose?

Test by trying to move the plaster longitudinally along the limb. Replace excessively loose or damaged casts, unless there is an outweighing risk of fracture slippage.

Local discomfort

If there is local pressure discomfort (eg over a malleolus), cut a window in the cast to allow direct inspection of the skin. Trim or replace plasters which restrict movement unduly.

Cast removal

Standard POP and selected resin casts may be removed with plaster shears. Use a plaster saw only after instruction in its proper use. In both cases, be careful to avoid skin damage. Note that some newer resin materials enable casts to be removed by being 'unwrapped', which has the advantage of being less stressful for children and parents can remove the cast themselves after a specified period of immobilization.

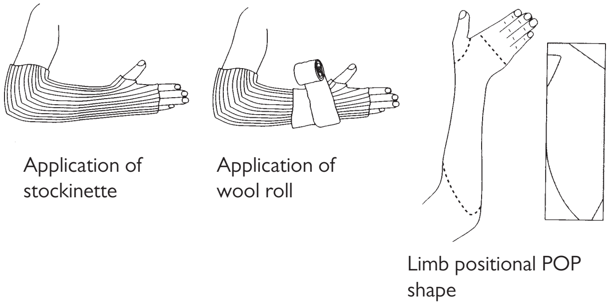


Fig. 9.4 Application of a Colles' backslab POP.

Fractures and osteoporosis

Osteoporosis is an important factor in a significant proportion of fractures seen in the ED. The following fractures are frequently (but by no means exclusively) associated with osteoporosis:

- Colles' fracture (see ➲ Colles' fracture, pp. 454–5).
- Fracture of the surgical neck of the humerus (see ➲ Humeral neck/head fracture, p. 472).
- Lumbar spine vertebral fracture.
- Fracture of the neck of femur (see ➲ Hip fractures, pp. 484–5).
- Pubic rami fracture (see ➲ Pelvic fractures, pp. 480–1).

Patients with post-menopausal osteoporosis may be treated with a bisphosphonate in an attempt to ↓ the risk of future fractures, but do not commence this treatment in the ED.

Soft tissue injuries

Sprains

These occur from overstretching and tearing of ligaments. Sprains vary from sparse fibrous tears to complete disruption of a ligament complex. The results are pain, tenderness, and swelling. Ligament sprains are traditionally graded into three types, although distinguishing clinically between them may be difficult:

- *First-degree sprains* involve minor tearing of fibres and are stable.
- *Second-degree sprains* are more severe partial sprains—there may be some resultant slight ligamentous laxity, but with a definite end-point on stressing.
- *Third-degree sprains* reflect completely torn ligaments causing significant laxity—patients sometimes report hearing a 'snap' at the time of injury.

Ligament sprains are very common, but there is a lack of reliable evidence about treatment. Prolonged immobilization seems to be detrimental to recovery, due to stiffness, muscle wasting, and loss of proprioception. Painful minor sprains respond well to traditional measures—ice, compression with elastic support/strapping, elevation, and progressive mobilization as soon as symptoms allow. Complete ligament rupture can be relatively painless, but, if associated with gross joint instability, may require surgical repair. Associated haemarthroses require orthopaedic appraisal, aspiration, and, often initially, protection and immobilization in POP.

Strains

Indirect injury involving muscle–tendon units may be classified in a similar fashion to ligament sprains. Pain on palpation over the site of injury is also reproduced by passive stress or active contraction of the affected muscle unit. Sometimes, a palpable defect may be apparent in complete ruptures (which typically occur at the musculotendinous junction). Treat minor strains similarly to sprains; consider specialist review for complete ruptures, some of which may require surgical repair.

Direct muscle injuries

These result from direct impact causing local pain, bruising, and soft tissue swelling. Note that associated bone contusions can occur such as in the perimeniscal areas of the knee (these are visible on MRI). Treat minor injuries with ice, analgesia, and early mobilization within the limits of symptoms. For more significant injuries, consider and treat according to possible risks of compartment and crush syndromes (with rhabdomyolysis) and large haematomas (see ➔ Haematomas, p. 432).

Haematomas

Blood can accumulate as a result of traumatic disruption of the vascular structures in bone, muscle, or soft tissues. Deceptively large volumes of blood can be accommodated within the soft tissue planes of the chest wall or thigh. In the presence of massive visible bruising of the torso or a limb, check for shock and measure Hb and Hct. Perform a coagulation screen. Blood transfusion may be necessary. Treat minor haematomas with compression dressings and ice. Large haematomas or supervening infection requires selective surgical drainage, haemostasis, and antibiotics.

Other soft tissue problems

Myositis ossificans

After some muscle or joint injuries, calcification can occur within a haematoma, leading to restriction of movement and loss of function. Frequent sites include calcification within a quadriceps haematoma (eg following a rugby injury) where inability to flex the knee >90° at 48hr after injury indicates an ↑ risk of myositis ossificans. Other sites include the elbow and femur. Passive stretching movements of joints may be implicated in the development of myositis ossificans. This particularly applies at the shoulder, hip, and knee where passive exercises are performed for spasticity following paraplegia or head injury.

Treatment involves immobilizing the limb or joint for a period of weeks, under specialist supervision. Early excision is contraindicated, as it is invariably followed by massive recurrence, but delayed excision (after 6–12 months) can improve function.

Tendonopathy (tendonitis/tenosynovitis)

This includes a wide range of conditions, some of which may have medicolegal implications ('overuse' or 'repetitive strain' injury). Examples include:

- *Classic tenosynovitis*: swelling along a tendon sheath, with pain on passive stretching or upon attempted active movement against resistance (eg de Quervain's tenosynovitis—see ➲ Soft tissue wrist injuries/problems, p. 459).
- *Chronic paratendonitis* (eg affecting Achilles tendon): swelling around the tendon with localized pain and tenderness.
- *Tendon insertion*: inflammation causes epicondylitis in adults (see ➲ Soft tissue elbow/arm problems, pp. 466–7) and traction apophysitis in children (➲ Osteochondritis, pp. 730–1).

Appropriate initial treatment usually includes rest, immobilization, and NSAID. Later, consider involving an appropriate specialist (eg physiotherapist or hand therapist).

Bursitis

Inflammation of bursae most frequently affects the subacromial, olecranon, and prepatellar bursae. There is localized swelling and tenderness—generalized joint effusion and/or tenderness along the whole joint line suggests an alternative diagnosis. In many instances, bursitis is non-infective and responds to rest and NSAID. Significant warmth and erythema raise the possibility of an infective origin. In this case, consider aspiration for bacteriological culture, and provide antibiotics (eg flucloxacillin or clarithromycin).

Other problems

Other causes of joint or limb pain with no specific history of trauma in the adult patient include stress fractures, cellulitis and other infections, osteoarthritis and other forms of acute arthritis, and nerve compression (eg carpal tunnel syndrome). Apparently atraumatic limb pain in children may present with limping—likely underlying causes vary according to the age (see ➲ The limping child, pp. 726–7).

Physiotherapy in the ED

Most simply, 'physiotherapy' includes advice given following minor injury. At the other extreme, it encompasses assessment and treatment of selected patients by skilled, experienced physiotherapists. It is valuable for the ED to have close links with a physiotherapy unit, preferably with designated physiotherapists in the ED responsible for referrals.

'Everyday' physiotherapy

Minor soft tissue injuries are amongst the most commonly seen problems in EDs. Once bony injury has been excluded (clinically and/or radiologically), ensure that patients are discharged with clear, consistent advice:

- Be clear and specific about what the patient is to do.
- Prescribe/provide appropriate slings, boots, and bracings, with advice on how to manage these.
- Give additional written instructions for reinforcement (eg ankle sprains, minor knee injuries), as patients forget much verbal advice.
- Set a realistic time limit after which the patient should seek further attention if their symptoms are not improving.

Protection/Rest/Ice/Compression/Elevation (PRICE)

The traditional basic framework for treatment of acute soft tissue injury.

Protection

Protect the injured part (eg using crutches or a walking stick).

Rest

With most acute injuries, advise a period of 24–48hr rest after an injury.

Ice

Ice is often advocated both in immediate first aid of soft tissue injuries and in subsequent treatment. Crushed ice cubes wrapped in a damp cloth (to avoid direct contact with the skin) placed against an injured joint may ↓ swelling and pain. Do not apply for more than 10–15min at a time. Repeat every few hours initially. A cold pack or bag of frozen vegetables can be used (do not refreeze if for consumption!).

Compression

Despite a lack of evidence, injured joints (particularly the ankle) are often treated with compression. The easiest is an elasticated tubular bandage (eg Tubigrip®), either single or doubled over. If provided, advise not to wear it in bed and to discard as soon as convenient. If not provided, explain why or the patient may feel inadequately treated. Avoid support bandages for elbow and knee injuries—they can be uncomfortable and 'dig in', and in the case of the knee, they may affect venous return and ↑ the chance of DVT.

Elevation

Initially, advise elevation of injured limbs above horizontal to ↓ swelling and discomfort. This is particularly important in hand or foot injuries.

Exercise

Start gentle, controlled exercises for any injured joint as soon as symptoms allow. Demonstrate what is expected and confirm that the patient understands what to do and how to progress rehabilitation appropriately.

Formal physiotherapy

Physiotherapists are trained in the rehabilitation and treatment of injury, based on a detailed knowledge of relevant limb and joint anatomy, biomechanics, and physiology. In the ED, physiotherapy staff are valuable in assessment and treatment of acute soft tissue injuries, patient education and advice, and the provision of appropriate mobility aids after injury (particularly in the elderly). Many EDs have adopted extended scope/advanced practitioner roles to further enable the therapist to deliver timely, appropriate, and cost-effective care—this includes triage, assessment, requesting/interpreting imaging, and managing soft tissue injuries and problems.

Utilizing physiotherapists

In order to make the best use of physiotherapy services, follow these guidelines:

- Refer early if required for acute injury. Ideally, aim for the patient to be seen for initial assessment the same day, so treatment needs can be properly planned. It should be acknowledged, however, that on occasions, it is necessary for the initial pain and swelling to settle before a definitive assessment can be made.
- Discuss the problem and treatment options with the physiotherapy staff prior to referral, where possible.
- Use the physiotherapy service for selected (rather than all) cases.
- Do not use the physiotherapy department to simply offload difficult or problematic patients.

Physiotherapists have a range of different treatments at their disposal, which typically focus upon regaining the range of movement and mobility and improving strength and proprioception.

Fracture clinic and alternatives

Traditionally, any patient who was discharged from ED with a fracture and/or significant soft tissue limb injury was followed up in the fracture clinic (or hand clinic). This system resulted in a large number of patients being seen at the wrong time by the wrong person (and often having to wait a long time for a consultation). A ground-breaking reorganization has been pioneered by a team at Glasgow Royal Infirmary (http://www.fractureclinicredesign.org). The new, more efficient system is now widespread. Patients with a range of relatively minor self-limiting fractures and injuries are discharged with advice ± splints (see ➔ Injuries discharged with advice sheet and no follow-up, pp. 436–7). All other patients are not allocated specific fracture clinic appointments but are referred to a 'virtual fracture clinic' where follow-up is timed and tailored to meet individual needs (as outlined in ➔ Virtual fracture clinic, p. 436).

Virtual fracture clinic

At the virtual fracture clinic, patients' notes and X-rays are reviewed and a decision is made about future management to suit their needs, which is then conveyed to the patient via a telephone discussion. This allows patients to have targeted treatment to suit their needs—to be discharged with advice, be brought back to see particular specialists (eg knee surgeon), have further tests (eg MRI), or return for review at a more appropriate time (rather than just attend the next available clinic).

Injuries discharged with advice sheet and no follow-up

Provide all patients who are discharged with an advice sheet and no follow-up a telephone number to call if they are worried, need advice, or would like to be seen for hospital follow-up. Examples of advice sheets used in Glasgow may be found at http://www.fractureclinicredesign.org

Torus/buckle wrist fracture (See ➔ Forearm and wrist injuries, p. 751 and Fig. 9.5.)

Aim to discharge most children with minor torus/buckle wrist fractures with a removable splint to wear for 3 weeks, together with advice regarding avoidance of sport for subsequent 2 weeks.

(a) (b)

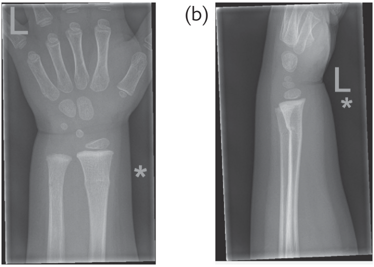


Fig. 9.5 Buckle fracture in a 2y old.

Undisplaced radial head/neck fracture (See ➔ Elbow injuries, pp. 462–3.)
Discharge patients with undisplaced radial head/neck fractures with a sling to wear whilst there is significant pain and advice not to forcibly extend the elbow and to expect recovery within 3–6 weeks.

Mallet finger injury (See ➲ Mallet finger with fracture, p. 444)
In the absence of a large bony fragment, discharge patients with a mallet finger injury with an appropriate splint and advice sheet outlining the importance of wearing the splint and keeping the finger straight for 6–8 weeks.

Clavicle fracture in children (See ➲ Clavicle and AC joint injuries, p. 471 and Fig. 9.6.)
Aim to discharge children with undisplaced or minimally displaced clavicle fractures with a sling for 2 weeks and written advice to avoid contact sports for 6 weeks.

Base of fifth metatarsal fracture (See ➲ Foot fractures and dislocations, pp. 504–5 and Fig. 9.7.)
Discharge patients with a base of fifth metatarsal (MT) fracture with crutches, an appropriate walking boot for 3–5 weeks, crutches, and advice.

Fifth metacarpal neck fracture (See ➲ Hand fractures and dislocations, pp. 444–5 and Fig. 9.8.)
Discharge patients with a fifth metacarpal (MC) neck fracture and no or minor angulation with buddy strapping and an advice sheet, with an expectation of recovery within 6 weeks or so.

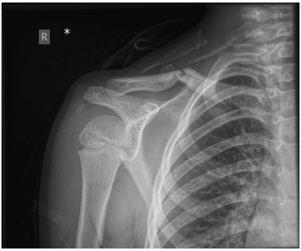


Fig. 9.6 Clavicle fracture in 7y old.

Fig. 9.7 Base of fifth MT fracture.

Fig. 9.8 Angulated fracture of fifth MC neck.

Approach to hand injuries

History

Determine and record whether the patient is right- or left-handed and their occupation and social situation. These points may have treatment implications (eg an elderly person living alone with little social support may not cope at home after a dominant hand injury).

Suspect patients presenting with wounds on the dorsum of the hand over the index, middle, ring, or little finger MC heads of having sustained a human bite ('fight bite'), whatever history is provided (see ➔ Specific bites and stings, pp. 422–3).

Terminology

To avoid confusion, always refer to fingers by name, not number (index, middle, ring, little).

Use: palmar (or volar), dorsal, radial, ulnar (not anterior, posterior, lateral, medial).

Bones of the hand and wrist

There are 14 phalanges and five MCs. Name the MCs according to the corresponding fingers (ie thumb, index, middle, ring, and little)—this avoids confusion. There are eight carpal bones arranged in two rows. The proximal row (radial to ulnar) comprises the scaphoid, lunate, triquetral, and pisiform (see Fig. 9.9). The distal row (radial to ulnar) are the trapezium, trapezoid, capitate, and hamate.

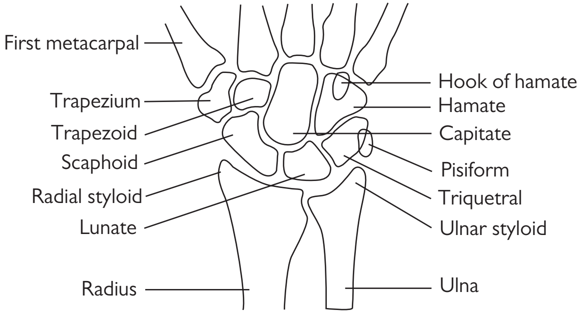


Fig. 9.9 AP view of a normal wrist.

Anatomy of finger extensor tendon (See Fig. 9.10.)

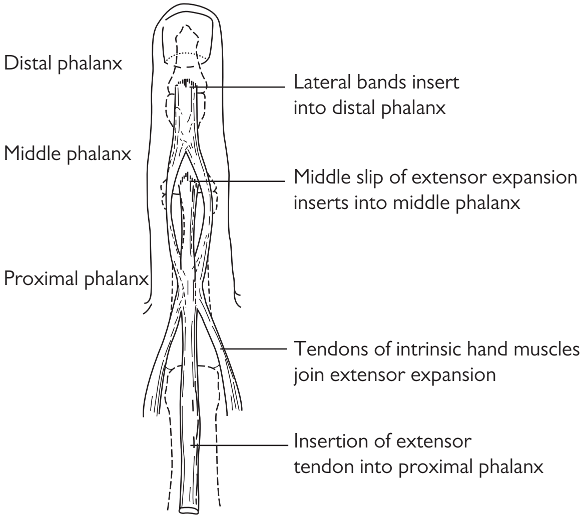


Fig. 9.10 Anatomy of finger extensor tendon.

Anatomy of finger flexor tendon (See Fig. 9.11.)

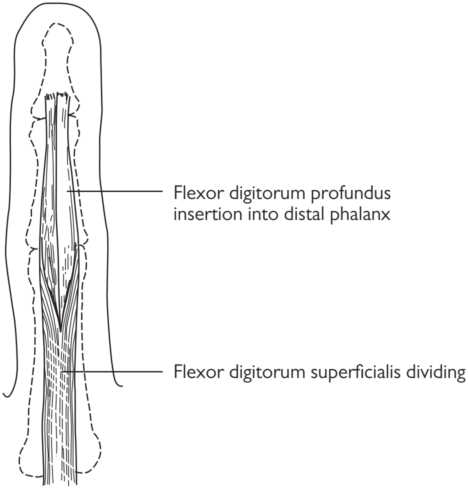


Fig. 9.11 Anatomy of finger flexor tendon.

Clinical signs of hand injury

Examination of hand injuries

Injury to the hand's rich collection of nerves, blood vessels, and tendons results in considerable functional deficit. Assess carefully, taking into account the hand anatomy and clinical patterns of injury (see Figs 9.12 and 9.13).

Specific signs of injury (See Table 9.2.)

Table 9.2 Specific signs of injury

Median nerve	↓ sensation in the palm over radial three-and-half digits, unable to abduct thumb against resistance
Ulnar nerve	↓ sensation in palmar and dorsal one-and-half fingers, little finger flexed (non-functioning lumbrical)
	Unable to cross index and middle fingers
	↓ abduction/adduction, weak pinch grip (Froment's sign)
Radial nerve	↓ sensation in dorsum first web space
	(No motor branches in hand, but proximal injury results in inability to extend wrist)
Digital nerve	↓ sensation along radial or ulnar half of digit distally—note that some sensation is usually preserved, even with significant nerve injuries
Superficial flexor	Hold other fingers straight (immobilizing all deep flexors), then unable to flex PIPJ (unreliable for index finger). Also, ~10% of individuals do not have a flexor superficialis tendon to the little finger
Deep flexor	Unable to flex DIPJ
Extensors	Complete division prevents extension (at DIPJ causes mallet deformity) Central slip division causes Boutonnière deformity In recent trauma, hold PIPJ at 90° over table edge, and try to extend against resistance—DIPJ hyperextends in central slip division (Elson's test)
Deformity	A small amount of rotational deformity of a digit (typically associated with a spiral/oblique MC or finger fracture) can have a dramatic effect upon long-term hand function (see Fig. 9.14)—check carefully to ensure that there is no abnormal overlapping of fingertips in the palm on making a fist

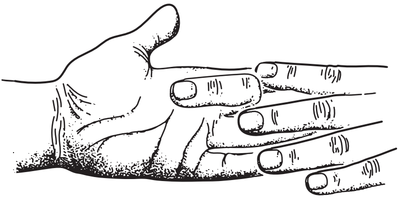


Fig. 9.12 Testing superficial flexor finger tendon.

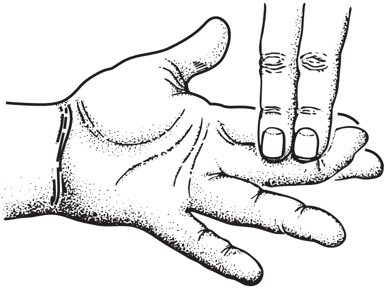


Fig. 9.13 Testing deep flexor finger tendon.

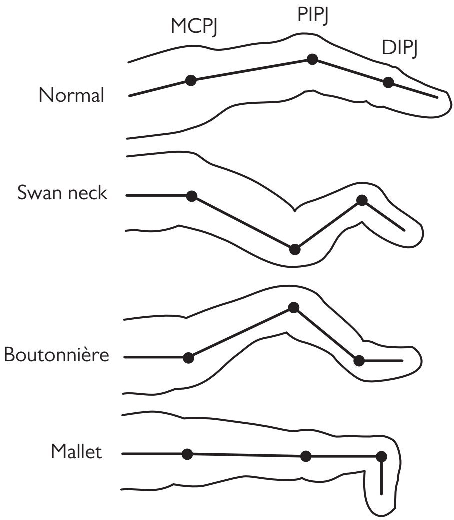


Fig. 9.14 Finger deformities.

Hand wounds and associated injuries

General principles of treating hand wounds

- Remove rings as soon as possible after any hand or arm injury, as swelling can develop relatively rapidly. Try soap or water-based lubricant or alternatively, pass a string or 0/0 silk under the ring and wrap it firmly around the finger distally, allowing the ring to come off over the compressed tissues. Ring cutters are a last resort—note that tungsten rings cannot be cut but can be removed by crushing and cracking in a vice.
- Elevate to diminish swelling and pain.
- Avoid subcutaneous sutures.
- Consider admitting patients who are unco-operative due to excess alcohol consumption, to allow suturing with better co-operation later.
- X-ray any hand injury caused by glass.
- Remember to consider tetanus cover.

Exploration under anaesthesia

If it is obvious that surgical intervention is required, do not explore the wound in the ED. This particularly applies to suspected nerve injuries where use of LA renders subsequent assessment difficult. Conversely, clinical assessment of tendon injuries can be misleading if the patient is reluctant to move due to pain. Exploration under anaesthesia is necessary in this situation and to exclude division of >50% of a tendon (where clinical examination may be normal, but repair is required). Use an appropriate LA nerve block (as outlined in ➲ Median and ulnar nerve blocks, pp. 306–7, Radial nerve block at the wrist, p. 308).

During exploration, consider the position of the hand at the time of injury—reproducing this may reveal injuries otherwise hidden. Therefore, put all mobile structures through their full range of movement.

Extensor tendon injuries

More than 50% or complete division needs repair (eg 4/0 or 5/0 non-absorbable monofilament using Bunnell or Kessler stitch) by an experienced surgeon. This may be achieved under LA in the ED, depending on expertise. Immobilize after repair (eg volar slab-type POP with finger joints in full extension and slight flexion at the MCPJs). Treat <50% division by splintage in extension (eg POP slab as above) under the care of the hand surgeon.

Flexor tendon injuries

Refer immediately for specialist repair.

Nerve injuries

Complete nerve division may cause surprisingly little sensory loss, so take any altered sensation very seriously. Refer patients with suspected nerve injuries. Digital nerves can be repaired up to the level of the DIPJ, although it may be decided not to attempt to repair injuries distal to the PIPJ. It is functionally important to have intact sensation over the 'edges' of the hand (the thumb, the radial aspect of the index finger, or the ulnar aspect of the little finger). Patients sometimes present late after digital nerve injuries—repair can still be quite successful up to 2 weeks after injury.

Reverse fight bites

Treat as outlined in ➲ Specific bites and stings, pp. 422–3. Consider transfer of blood-borne infection, as discussed in ➲ Needlestick injury, p. 425.

Amputations

Refer patients with partial or complete digital amputation with bony loss. Recent proximal amputations without crush injury in fit young patients may be suitable for re-implantation—others may be treated with 'terminalization' or advancement flap. Let the hand surgeon decide. Meanwhile, dress, bandage, and elevate; give IV analgesia, tetanus cover, and broad-spectrum antibiotics (eg cephalosporin), and keep fasted. Wrap the amputated part in moist saline swabs, and place in a sealed plastic bag, surrounded by ice/water mix at 4°C. Do not freeze or place it directly in solution.

Finger pad amputations

Skin loss of <1cm^2 without bony exposure may be allowed to heal with non-adherent dressings. Larger areas of tissue loss (particularly in adults) may require skin grafting or advancement flap, but some do heal satisfactorily with simple dressings.

Ring avulsions

Refer all circumferential and significant degloving injuries.

Open (compound) injuries

Wounds over dislocations or fractures usually require specialist attention. Distal open phalangeal fractures may be treated in the ED with wound cleaning, closure, review, and prophylactic antibiotics.

Crush injuries

These frequently cause 'burst' injury fingertip wounds. Clean the wounds, and take into account the likely swelling when considering closure. Elevate, dress, give analgesia, and arrange review.

Nail bed lacerations

Accurate repair (eg 6/0 Vicryl) may prevent nail deformity. Nailfold lacerations extending towards the nail bed require removal of the nail to allow suture. Consider replacing the nail after to act as a temporary dressing.

Foreign bodies under the nail

Splinters and other FBs under fingernails are relatively common. Apply a digital block and remove with fine forceps. If the FB cannot be reached easily, cut away an appropriate piece of nail.

Subungual haematomas

Blood collecting under the nail from a crush injury causes pain. If >50% of the nail is affected by a recent injury (within 48hr), trephine the nail distal to the lunula, using a red hot paper clip or battery-operated drill.

High-pressure injection injuries

Industrial grease or paint guns may cause small skin wounds, which initially appear trivial, disguising a devastating injury, with a risk of permanent stiffness and tissue loss. X-rays may indicate the extent of foreign material. Refer to a hand surgeon for immediate exploration and debridement.

Hand fractures and dislocations

Distal phalangeal fractures

Treat closed fractures of the distal portion (tuft) of the distal phalanx with analgesia and elevation. Open (compound) burst injuries (from crushing injuries or hammer blows) require meticulous exploration, wound toilet/repair under LA, and follow-up—local policy will guide if this may be delivered in the ED or under the hand surgeon as an inpatient. Give antibiotics (not a substitute for primary surgical treatment).

Mallet finger with fracture

The characteristic 'mallet finger' deformity (see Figs. 9.15 and 9.16) may be associated with a small fracture at the base of the distal phalanx at the point of attachment of the extensor tendon. Treat as for (the more usual) mallet finger injury without fracture by plastic mallet splint for ~6 weeks, advice, and follow-up (see details in ➔ Soft tissue hand injuries, p. 448). Refer patients with larger bony fragments (more than one-third of articular surface) with mallet deformity or those with subluxation for possible K-wire internal fixation.

Fig. 9.15 Mallet finger deformity.

Fig. 9.16 Mallet finger injury due to tendon rupture.

Proximal and middle phalangeal fractures

Treat undisplaced fractures with elevation, neighbour strapping (see Fig. 9.17), and analgesia. Manipulate angulated proximal and middle phalangeal fractures under digital or wrist block. A useful tip for proximal phalangeal fractures is to use a needle-holder or a pencil placed adjacent to the web space as a fulcrum. Maintain reduction using neighbour strapping and a volar slab POP or flexible padded aluminium (Zimmer) splint, although the latter can be difficult to secure. If reduction is unsatisfactory or cannot be maintained, refer for surgical fixation.

Index, middle, and ring metacarpal fractures

Check for displacement or rotational deformity, and refer if either is present. Treat with analgesia and elevation, and protect in a volar slab POP. Internal fixation may be considered for midshaft MC fractures with marked angulation but can be complicated by marked postoperative stiffness.

Phalangeal dislocations

X-ray all dislocations prior to reduction for the presence of associated fractures. Reduce under digital or metacarpal nerve block (see ➲ Digital nerve block, pp. 304–5) or Entonox® by traction and gentle manipulation, then check the integrity of the collateral ligaments. Confirm reduction on X-ray, and immobilize the finger by neighbour strapping. Elevate the hand; provide oral analgesia, and arrange hand clinic follow-up.

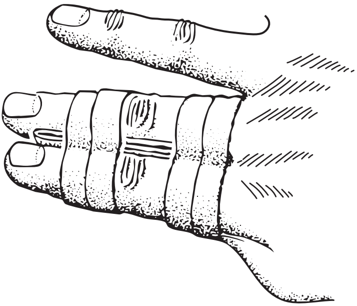


Fig. 9.17 Neighbour (buddy) strapping.

Little (fifth) metacarpal fractures

These commonly result from punching (see Fig. 9.8). Check for rotational deformity by gently flexing the fingers into the palm (they should point roughly to the thenar eminence and touch, but not overlap, adjacent fingers on flexion). Angulation is common with neck fractures and rarely requires correction, with even up to 40° being accepted. Apply neighbour strapping; elevate and give analgesia. Warn the patient that the fifth knuckle will be shorter than before. Traditional fracture/hand clinic follow-up for uncomplicated injuries are increasingly being replaced by written advice with no follow-up (unless problems arise—see ➲ Fracture clinic and alternatives, pp. 436–7). Whatever the follow-up arrangements, ensure that the patient is aware of the importance of appropriate hand exercises as soon as possible.

Refer to the orthopaedic team if there is rotational deformity or significant angulation, particularly with base and shaft fractures, which may need surgery. Also refer patients with associated wounds, remembering that these may be compound human bites ('reverse fight bites'—see ➲ Specific bites and stings, pp. 422–3).

Little (fifth) metacarpal dislocations

Dislocations at the base of the fifth MC may be associated with a fracture. Refer for reduction and internal fixation.

Thumb fractures and dislocations

Dislocation at the metacarpophalangeal joint

(See Fig. 9.18.)

After X-rays and LA block, attempt reduction. If successful, assess and document the integrity of the collateral ligaments (see ➲ Soft tissue hand injuries, p. 448), then immobilize in slight (~15°) flexion in a POP and arrange follow-up in the fracture clinic. Reduction may be unsuccessful due to 'button-holing'—in this case, refer for open reduction.

Gamekeeper's thumb with associated avulsion fracture

Most abduction injuries result in ulnar collateral ligament injury without fracture, but occasionally an avulsion fracture occurs at the point of ligament attachment instead (see Fig. 9.19). Treat this in a scaphoid POP and refer to the fracture clinic, unless the bony fragment is displaced by >2mm, in which case internal fixation will probably be required. If undisplaced, treat in scaphoid POP and refer to the fracture clinic, but if displaced, refer for internal fixation.

Thumb dislocations

Dislocations usually follow falls onto the thumb or hyperextension injuries. They can occur at any level, including at the interphalangeal joint (IPJ), MCPJ, and carpometacarpal joint. Reduce dislocations by traction and local pressure under combined median and radial nerve blocks (see ➲ Median nerve block, p. 306), Radial nerve block, p. 308. Confirm reduction by X-ray; immobilize in a scaphoid POP, and arrange follow-up.

Fig. 9.18 Dislocated thumb at the MCPJ.

(a) (b)

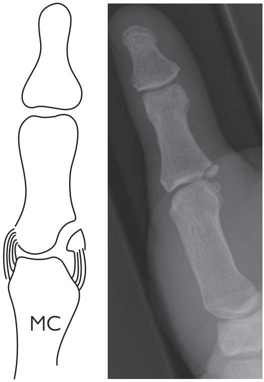


Fig. 9.19 (a) Diagram of gamekeeper's thumb with avulsion; (b) X-ray of gamekeeper's thumb with avulsion.

Bennett's fracture–dislocation

(See ➲ Eponymous fractures, pp. 514–18.)

This is a fracture through the base of the thumb (first) MC, with radial subluxation of the MC, leaving a small proximal fragment still joined to the trapezium (see Fig. 9.20). The injury results from a fall onto the thumb or from a fall/blow onto a fist closed around the thumb. Deformity and swelling occur over the base of the thumb and may be mistaken clinically for a scaphoid injury. This is an unstable injury requiring expert attention. If undisplaced, apply a Bennett's-type POP (similar to a scaphoid POP, but with the thumb abducted). If there is any displacement, refer for MUA/fixation. Maintaining reduction often requires the use of screw or Kirschner wire fixation.

(a) (b)

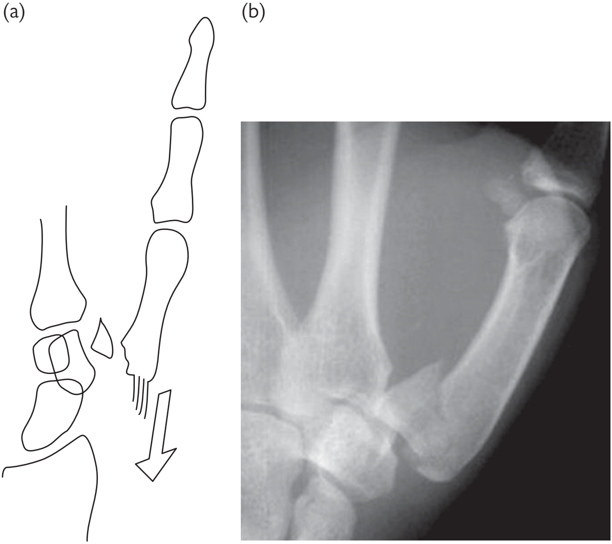


Fig. 9.20 (a) Diagram of Bennett's fracture–dislocation; (b) X-ray of Bennett's fracture–dislocation.

Soft tissue hand injuries

Gamekeeper's thumb

The thumb's ulnar collateral ligament is crucial for stability and function. It is typically injured in hyperabduction injuries (eg falls whilst skiing). Complete rupture usually results in the two parts of the ligament being separated by the adductor aponeurosis (the 'Stener lesion'), so satisfactory healing cannot occur. If tender over the ulnar collateral ligament of the thumb MCPJ, obtain X-rays—if these demonstrate a fracture, do not stress the joint, but treat appropriately instead (see ➲ Thumb fractures and dislocations, pp. 446–7). If no fracture, assess stability of the ulnar collateral ligament by gentle abduction of the MCPJ (compare with the other hand). Examine the ulnar collateral ligament with the thumb slightly (15°) flexed. If pain precludes adequate examination, consider Entonox® (and/or LA injection) and repeat the examination. Significant (>30°) laxity implies complete rupture and the need for operative repair.

Treat uncomplicated sprains with analgesia, elevation, and either criss-cross adhesive strapping ('thumb spica') or a scaphoid POP if symptoms are severe, and arrange follow-up. Refer suspected or demonstrable ulnar collateral ligament rupture to consider primary surgical repair.

Mallet finger

Injury to the extensor mechanism at the DIPJ is relatively common and results from forced flexion of the DIPJ or from a blow/fall directly onto the fingertip. In the elderly, it can follow minimal trauma. There is loss of full active extension at the DIPJ. Normal flexion is preserved.

X-ray to exclude associated fracture—treated as outlined in ➲ Hand fractures and dislocations, pp. 444–5.

In the absence of a large fragment, treat in a plastic (mallet) splint secured with tape for ~6wk (see ➲ Hand fractures and dislocations, pp. 444–5). Ensure the patient understands the need to wear the splint continuously and to keep the finger straight if the splint is removed for washing (eg to hold the finger against a flat surface until the splint is replaced). Warn that there may be a small degree of permanent flexion deformity. Consider initial follow-up at ~7–10 days, to ensure compliance with treatment and to reassess in case swelling has ↓ and a smaller splint is required.

Volar plate injury

These are significant injuries, often with prolonged morbidity. Hyperextension at the PIPJ injures the *volar plate* at the base of the middle phalanx, with or without evidence of bony involvement. Examination shows fusiform swelling of the PIPJ, with tenderness over the volar aspect. Treat with 'buddy strapping' to adjacent fingers (or 'Bedford splint'), elevate, provide analgesia, and begin mobilization immediately. Arrange review to ensure full mobility is regained.

A2 pulley injury

The finger flexor tendon sheath at the PIPJ is thickened as the A2 pulley. Occasionally (eg in rock climbers), the tendon cuts through the A2 pulley, causing bowstringing on flexion. There may be associated tendon injury. Treat with buddy strapping and elevation. Arrange hand specialist follow-up.

Other soft tissue hand problems

Pulp infections

Infection of the pulp space at the fingertip may reflect underlying FB or osteomyelitis, so X-ray to search for these and treat accordingly. If X-rays are normal, incise the pointing area under LA digital block. Send pus for bacteriology; apply a dressing, commence oral antibiotics (eg flucloxacillin 250–500mg PO qds), and arrange follow-up.

Paronychia

Infection of the nailfold adjacent to the nail is common. In the early stages, oral antibiotics (eg flucloxacillin or clarithromycin) may cure.

Once pus has developed, drain this under LA digital block by an incision over the fluctuance (usually a small longitudinally orientated incision adjacent to the proximal nailfold suffices, but pus under the nail may require removal of a segment of the nail). Alternatively, incise immediately adjacent to and along the affected lateral nailfold. Once drained, do not give antibiotics, unless there is cellulitis or spreading infection or the patient is immunocompromised and/or has diabetes.

Pyogenic flexor tenosynovitis

Infection of a finger flexor tendon sheath may follow a penetrating injury. Classically, the evidence is in the form of 'Kanavel's signs':

- Tenderness over the flexor tendon.
- Symmetrical swelling of the finger.
- Finger held in flexion.
- Extreme pain on passive extension.

Ensure tetanus prophylaxis, then refer urgently for exploration, irrigation, and IV antibiotics.

Other infections

These include palmar space infections and septic arthritis—refer immediately for specialist treatment.

Locked finger

Elderly patients with underlying osteoarthritis (OA) sometimes present with locking at a finger MCPJ. A fixed flexion deformity is present, such that the patient can flex but not fully extend at the MCPJ. There is usually no particular history of trauma—the underlying cause is entrapment of the palmar plate on an osteophyte. Refer for an early hand surgeon opinion—surgery may be required.

Trigger finger/thumb

This is relatively common, but not particularly related to trauma. In young children, many resolve spontaneously, although some require surgery. Most cases in adults are satisfactorily treated by steroid injection into the flexor tendon sheath, but leave this to a specialist.

Scaphoid fracture

Background

Spanning the two rows of carpal bones, the scaphoid is at particular risk of injury. Scaphoid fractures occur from falling onto an outstretched hand or from 'kick-back' injuries (eg from a steering wheel in a car crash or a football goalkeeper making a save).

The combination of fractures being difficult to identify on X-ray and the risk of significant complications (non-union, avascular necrosis) demands a careful approach. The scaphoid mostly fractures through the waist, but sometimes through the tubercle (the latter does not give rise to significant complications).

Clinical assessment

Assess and document whether there is evidence of scaphoid fracture in anyone who presents with a wrist injury. Pain and swelling over the radial aspect of the wrist may be accompanied by difficulty gripping.

Examine for:

- Tenderness in the anatomical snuffbox—compare both sides.
- Tenderness over the palmar aspect of the scaphoid (scaphoid tubercle).
- Scaphoid pain on compressing the thumb longitudinally.
- Scaphoid pain on gentle flexion and ulnar deviation of the wrist.

X-rays

Fractures of the scaphoid may be difficult to see (or not be apparent at all) on initial X-rays. Request specialized scaphoid (not wrist) views if there is clinical suspicion of scaphoid fracture. Four views are usually taken (AP, lateral, right, and left obliques), as shown in Fig. 9.21.

Treatment where a fracture is visible

If there is a visible fracture on X-ray, immobilize in a cast and arrange follow-up in the hand/fracture clinic. Although it is traditional to apply a scaphoid-type POP, evidence suggests that it is equally acceptable to use a Colles-style POP.

Fig. 9.21 Scaphoid waist fracture.

Clinically suspected scaphoid fracture

If there is clinical suspicion of a scaphoid fracture, but the X-rays look normal, apply a splint and arrange review (usually in 10–14 days). Most of these patients will turn out not to have a fracture, but failing to adequately immobilize those patients who do have a fracture may ↑ the risk of complications.

Follow-up of clinically suspected scaphoid fractures

Patients with clinically suspected scaphoid fractures (but normal X-rays) are often seen in the ED clinic. Aim to discharge patients if there is no clinical evidence of fracture at review at 10–14 days after injury. If, however, there is continuing pain and/or scaphoid tenderness, arrange further imaging. The choice includes repeat X-rays, MRI, and CT. Of these, MRI has the advantage of avoiding ionizing radiation and the potential to pick up other injuries not seen on X-ray (see Figs. 9.22a and b).

(a) (b)

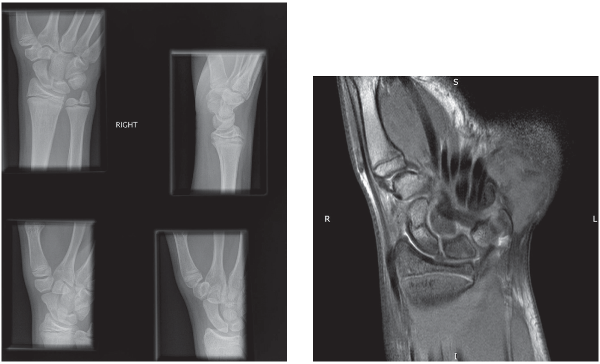


Fig. 9.22 Scaphoid fracture in 15y old seen at 2 weeks on (b) MRI, but not (a) X-ray.

Complications of scaphoid fracture

These include non-union, avascular necrosis, and OA. Sometimes patients present with symptoms relating to one or more of these, but often an abnormality is picked up as an incidental finding—the patient may not even have any recollection of previous injury (see Fig. 9.23). Arrange specialist follow-up (may be most appropriately achieved via the GP).

Fig. 9.23 New index MC fracture with incidental old non-union of the scaphoid plus associated avascular necrosis of the proximal pole (which has a sclerotic appearance).

Lunate dislocation

These injuries are rare, but important, as they are often missed, yet require urgent admission for MUA. Lunate dislocations usually follow falls onto an outstretched wrist and result in pain and swelling anteriorly over the wrist (see Fig. 9.24). Median nerve paraesthesiae may be a clue to the diagnosis. X-ray shows dislocation and rotation of the lunate, so that it is shifted in front of the carpus and its concave surface faces towards the palm instead of distally. The AP view may look relatively normal, so carefully scrutinize the lateral views. It may help to compare with normal X-rays (see Fig. 9.25).

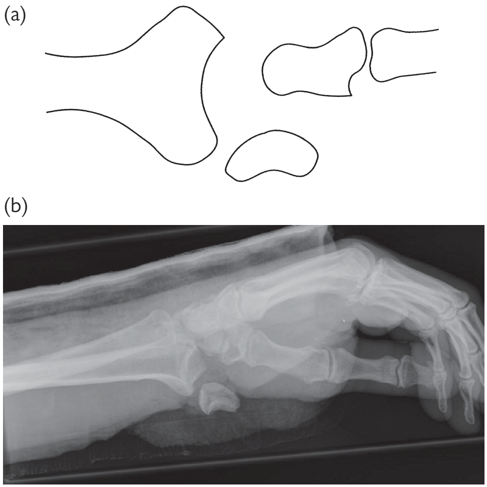


Fig. 9.24 (a) Diagram of lunate dislocation. (b) X-ray of lunate dislocation (as part of a complex wrist injury).

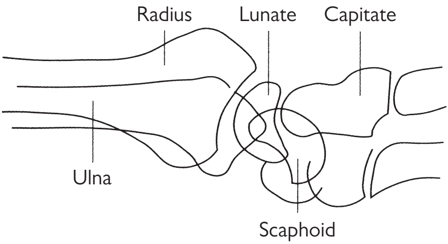


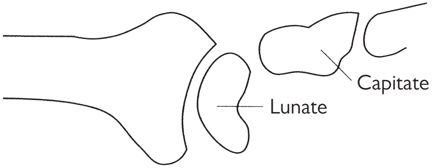
Fig. 9.25 Wrist: normal lateral view.

Other carpal injuries

Perilunate dislocation

Isolated dislocations of carpal bones, apart from the lunate, can occur, but often injuries are more complicated and involve dislocations (and fractures) of one row of carpal bones (eg trans-scaphoid perilunate dislocation) (see Fig. 9.26). Surprisingly, perhaps, given almost inevitable significant swelling, these injuries can be missed. Give analgesia and refer for reduction by the orthopaedic team.

(a)



(b)

Fig. 9.26 (a) Diagram of perilunate dislocation. (b) X-ray of perilunate dislocation.

Fractured hook of the hamate

Local palmar tenderness may give rise to suspicion of a fracture of the hook of the hamate. Diagnosis can be difficult—specialized X-rays or CT may be required to demonstrate the fracture. Immobilize in POP and refer to the fracture clinic.

Flake avulsion carpal fractures

Small avulsions from the dorsum of the carpus are often from the triquetrum (see Fig. 9.27). Treat with immobilization in a POP backslab or a wrist support splint and analgesia, and refer to the fracture clinic.

Fig. 9.27 X-ray of triquetral avulsion fracture.

Colles' fracture

Presentation

This fracture affects the radius within 2.5cm of the wrist, such that the distal fragment is angulated to point dorsally. It usually results from a fall onto an outstretched hand. Osteoporosis contributes to an ↑ frequency in post-menopausal women. Colles' fractures produce characteristic clinical deformity (sometimes likened to a 'dinner fork'). Check for scaphoid tenderness, distal sensation, and pulses in all cases.

Radiological features

X-ray appearances include one or more of the following:

- Posterior and radial displacement (translation) of the distal fragment.
- Angulation of the distal fragment to point dorsally (the articular surface of the distal radius normally has a 5° forward tilt on the lateral wrist X-ray) (see Fig. 9.28).
- Angulation of the distal fragment to point more radially (the articular surface of the distal radius is normally tilted 22° towards the ulnar side on an AP wrist X-ray) (see Fig. 9.29).
- Impaction, leading to shortening of the radius in relation to the ulna.

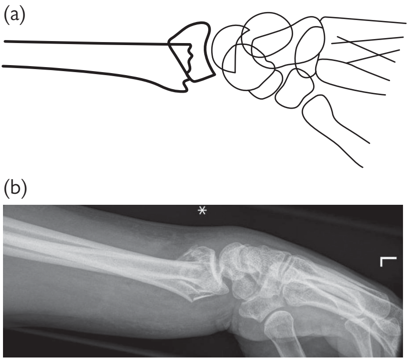


Fig. 9.28 (a) Diagram and (b) X-ray of Colles' fracture, lateral view.

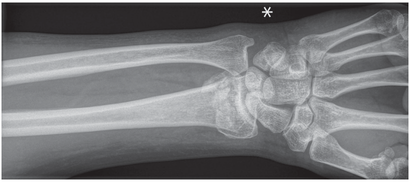


Fig. 9.29 Diagram of Colles' fracture, AP view—there is comminution of the distal radius, with shortening of the radius in relation to the ulna.

Treatment

Provide analgesia; immobilize in a backslab POP, and elevate with a sling. Discharge those with undisplaced fractures (if they will manage at home), and arrange fracture clinic follow-up. Advise the patient to keep moving the fingers, thumb, elbow, and shoulder.

Deciding if MUA is indicated

MUA is required for:

- Grossly displaced fractures.
- Loss of normal forward radial articular surface tilt on lateral wrist X-ray. Neutral or minimal tilt may be acceptable in the very young or very old (particularly in the non-dominant limb). Seek senior advice if unsure.

Timing of MUA

Patients with compound fractures and/or symptoms of nerve compression require urgent MUA. For many other patients, the timing of the procedure is less important. Many EDs undertake closed manipulation of Colles' fractures in adult patients at the time of initial presentation, whilst others arrange for the patient to return for the procedure within 1–2 days to a specific theatre list as a day case.

During manipulation of Colles' fractures, focus particularly upon reducing the angulation and displacement of the distal radius seen on the lateral view (see Fig. 9.30).

(a) (b)

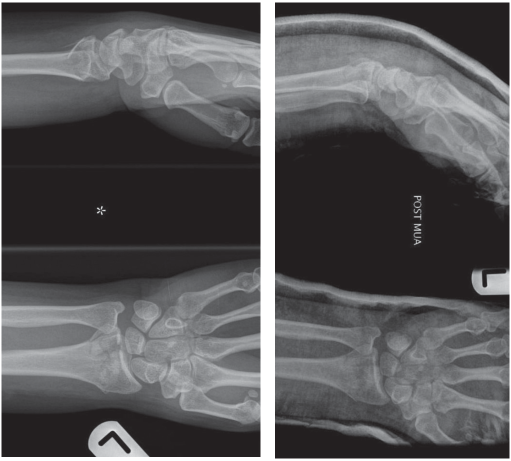


Fig. 9.30 X-rays of angulated Colles' fracture before (a) and after (b) manipulation.

Manipulating Colles' fractures

Consent

Discuss the risks and benefits of the procedure. In particular, explain that, if left untreated, an angulated Colles' fracture may result in long-term stiffness and a significantly weaker grip. The principal risks of manipulation are:

- Tears to the skin on the dorsum of the wrist (especially in those with thin skin, eg patients on steroids, and/or significant swelling, eg those on warfarin).
- Late slippage of the bones requiring a further procedure.
- Risks of the anaesthesia employed.

Choice of anaesthetic

The anaesthetic options available include: haematoma block (see ➲ Local anaesthetic administration, p. 299), IV regional anaesthesia (see ➲ Bier's block, pp. 300–1), IV sedation (see ➲ Approach to sedation, pp. 316–17), and GA (see ➲ General anaesthesia in the ED, pp. 320–1). The choice of anaesthetic will depend upon local protocols, as well as patient-related factors such as the type of fracture and extent of fasting. For example, a minimally angulated fracture in an elderly individual may be satisfactorily managed using a haematoma block, whereas a more dramatically angulated and displaced fracture may not. Evidence suggests that Bier's block is superior to haematoma block (see http://www.bestbets.org).

Technique

Different individuals may employ different techniques, but the aim is to attempt to return the anatomy to its previous position. In particular, it is important to correct the dorsal angulation ('restore the volar cortex'). Many descriptions of reduction techniques involve initial traction and 'disimpaction' of the fragments, followed by wrist flexion and pronation, with pressure over the distal radial fragment(s). Some operators focus more upon gentle direct manipulation of the distal fragment, rather than indirect measures (traction, wrist flexion, etc.).

Following manipulation, apply a backslab POP, whilst maintaining the reduction, with the wrist slightly flexed and pronated (avoid excessive flexion as this can cause additional long-term problems). Satisfactory reduction can be confirmed by image intensifier/X-ray. If the reduction is not satisfactory, repeat the manipulation procedure.

Medium- and long-term complications of Colles' fracture

Patients may present to the ED with later complications following Colles' fracture (and the treatment provided for it), including the following:

- *Stiffness of wrist and adjacent limb joints*: refer for physiotherapy.
- *Malunion and cosmetic problems*: refer to the GP/orthopaedic team.
- *Reflex sympathetic dystrophy (Sudeck's atrophy)*: refer for physiotherapy and GP/orthopaedic follow-up.
- *Carpal tunnel syndrome*: this may occur after Colles' fracture but also reflects other problems (eg lunate dislocation)—check original X-rays.
- *Extensor pollicis longus rupture*: this may occur some weeks after fractures with minimal displacement (see ➲ Soft tissue wrist injuries/problems, p. 459).

Smith's fracture

This is an unstable distal radius fracture (sometimes referred to as a 'reverse Colles' fracture') where the distal fragment is impacted, tilted to point anteriorly, and often displaced anteriorly (see Fig. 9.31). It usually follows a fall onto a flexed wrist. Give analgesia; immobilize in a volar slab POP, and refer for MUA (often difficult to hold in position after reduction) or open reduction and internal fixation (ORIF) using a buttress plate (preferred in some orthopaedic centres).

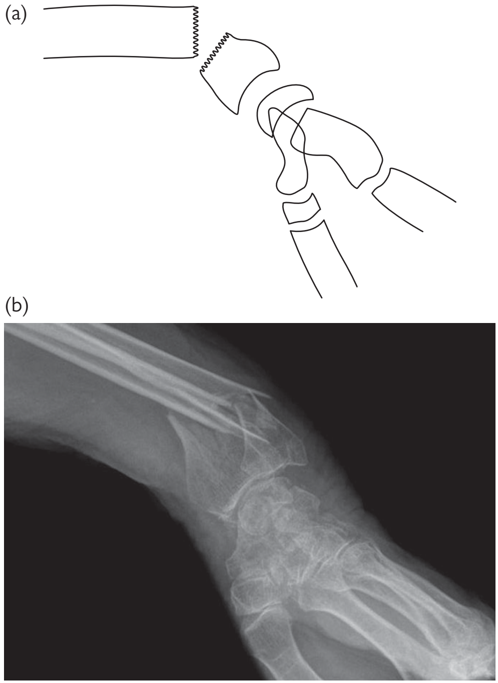
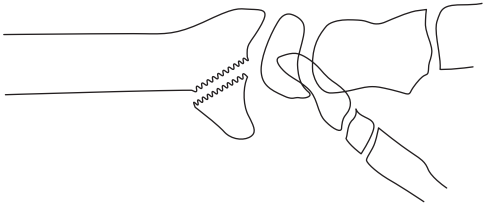


Fig. 9.31 (a) Diagram of Smith's fracture (lateral view). (b) X-ray of Smith's fracture (there is also a fracture of the distal ulna).

Barton's and reverse Barton's fracture

An intra-articular fracture involving only the dorsal or volar portion of the distal radius is called a Barton's fracture and reverse Barton's fracture, respectively (see Fig. 9.32), although describing them as 'dorsal Barton's fracture' and 'volar Barton's fracture' may avoid possible confusion. The resultant dorsal or volar fragment tends to slip, so the fracture is inherently unstable. Provide analgesia; immobilize in a POP backslab, and refer. Most patients require ORIF and plating.

(a)



(b)

Fig. 9.32 (a) Diagram of lateral view of a reverse (volar) Barton's fracture. (b) X-ray (lateral view) of a reverse (volar) Barton's fracture.

Isolated radial styloid fracture

This is caused by similar mechanisms of injury as scaphoid fractures (ie falls onto an outstretched hand or kick-back injuries). It is sometimes referred to as a Hutchinson fracture (see ➔ Eponymous fractures, pp. 514–18). Treat with analgesia, backslab POP, and an elevation sling, and refer to the fracture clinic. Internal fixation is occasionally required.

Soft tissue wrist injuries/problems

Wrist sprain

Exclude scaphoid or other fracture (or dislocation) before considering the diagnosis of a 'simple wrist sprain' (triquetral avulsions are particularly easy to miss—see ➲ Flake avulsion carpal fractures, p. 453). Relatively minor damage to ligaments around the wrist can occur following hyperextension or flexion of the wrist, causing swelling and tenderness around the joint. Treat with a wrist splint or Tubigrip® (elasticated tubular) support, analgesia or NSAIDs, and progressive exercise. Continuing pain and problems arouse suspicions of more significant injury (possibly involving other structures such as the scapholunate ligament or triangular fibrocartilage complex). Refer for specialist investigation.

Triangular fibrocartilage complex injury

The triangular fibrocartilage complex (TFCC) at the distal end of the ulna may be injured with associated structures. Often, these injuries only become apparent later, when what was diagnosed as a 'simple wrist sprain' fails to settle—pain and tenderness persist over the TFCC. Arrange specialist follow-up for further investigation (eg MRI) and treatment.

Rupture of wrist/hand tendons

Rupture of tendons may occur without penetrating trauma. The most common rupture involves the extensor pollicis longus a few weeks after a (usually undisplaced) fracture of the distal radius. Rupture of other extensor (and occasionally flexor) tendons occurs in association with OA, rheumatoid arthritis (RA), scaphoid non-union, CRF, and SLE. Refer to a hand surgeon.

Radial tenosynovitis ('intersection syndrome')

This typically follows unaccustomed repetitive activity such as gardening, DIY, or decorating. Over hours to days, a painful fusiform swelling develops over the radial aspect of the distal forearm. Movement of the wrist produces pain and palpable (occasionally audible) crepitus. Immobilize in a simple adjustable wrist splint, and unless contraindicated, prescribe an NSAID for 7–10 days. After this, allow gradual mobilization of the wrist and educate about eliminating the cause. Immobilize severe cases in a forearm POP for 2 weeks before beginning mobilization.

de Quervain's tenosynovitis

Affects the tendon sheaths of the abductor pollicis longus and extensor pollicis brevis. Pain, swelling, and crepitus occur over the lateral (dorsoradial) aspect of the radial styloid. Symptoms can be reproduced by thumb or wrist movement. Finkelstein described grasping the patient's thumb and rapidly 'abducting the hand ulnarward', but probably more useful is pain on ulnar movement of the wrist with the thumb clenched in a fist. Treat with an NSAID and splintage for 7–10 days. A removable fabric wrist splint (including the thumb) may suffice, but consider a POP for severe pain. Persistent symptoms may respond to steroid injection of the tendon sheath using an aseptic technique.

Forearm fractures and related injury

▶ *If one forearm bone is fractured, look for a fracture or dislocation of the other.*

Obvious deformity in an adult forearm indicates fracture of the radial and ulnar shafts. Initially treat with:

- Analgesia (eg increments of IV morphine + antiemetic until pain is relieved).
- Immobilization in backslab POP.
- If one or both fractures are compound, give IV antibiotics (see ➲ Open (compound) fractures, pp. 428–9) and tetanus cover, and dress the wound.

Always check distal pulses and sensation, and examine for associated injuries at the wrist and elbow. Only once this has been done and the patient is comfortable can he/she be sent for X-ray. Ensure X-rays demonstrate the whole lengths of the radius and ulna, including separate views of both the elbow and wrist joints.

Fractures of both radial and ulnar shafts

Adult fractures, unlike those in children, may be markedly displaced, with little or no bony contact between the fragments. Rotational deformity is common. Check carefully for clinical evidence of neurovascular injury. Closed reduction is difficult and often fails or is complicated by late slippage. Treat fractures with analgesia/immobilization as described earlier, and refer for ORIF.

Isolated ulnar shaft fracture

These usually occur from a direct blow to the outer edge of the forearm (it is typically seen as a defence injury) or from a fall striking the ulnar shaft. X-ray the whole ulna and radius to exclude associated fracture or dislocation of the radial head (see ➲ Monteggia fracture–dislocation, p. 461). If undisplaced, treat in an above-elbow POP, with the elbow flexed to 90° and the forearm in mid-supination. Refer all displaced or angulated fractures for ORIF.

Galeazzi fracture–dislocation (See ➲ Eponymous fractures, pp. 514–18.)

This is defined as a fracture of the radius associated with dislocation of the distal radio-ulnar joint at the wrist (see Fig. 9.33). Always look for subluxation of the ulna in radial fractures. Treat with analgesia and immobilization in a temporary POP backslab. Refer for ORIF.

Fig. 9.33 Galeazzi injury—fractured radius plus disrupted radio-ulnar joint.

Monteggia fracture–dislocation

(See ➲ Eponymous fractures, pp. 514–18.)

This is defined as a fracture of the ulna associated with dislocation of the radial head. It occurs from forced pronation of the forearm (eg fall onto an outstretched, fully pronated forearm). It can also occur by a direct blow or fall onto the proximal ulna, displacing the head of the radius. Treat with analgesia and immobilization in a temporary above-elbow POP backslab. Refer to the orthopaedic team for ORIF (or, sometimes in children, for treatment with MUA and POP).

A related injury is the *Hume fracture* (see ➲ Eponymous fractures, pp. 514–18), in which anterior dislocation of the radial head is combined with an olecranon fracture. Refer for ORIF.

Note: Monteggia fracture–dislocations are not infrequently missed at initial presentation, due to attention being distracted by the ulna fracture (see Fig. 9.34). To avoid this:

- Request elbow and wrist X-rays in any patient with a forearm shaft fracture.
- Check all elbow X-rays carefully to ensure that the radial shaft is normally aligned and the radial head abuts the capitellum.

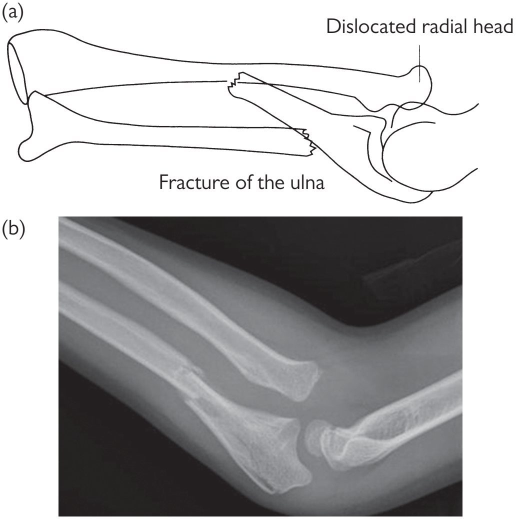


Fig. 9.34 (a) Monteggia fracture–dislocation; (b) X-ray of Monteggia fracture–dislocation.

Isolated radial shaft fracture

These are very uncommon. Always treat and assume that there is some associated damage to the distal radio-ulnar joint at the wrist.

Elbow injuries

Assessment

In any injured elbow, look specifically for:

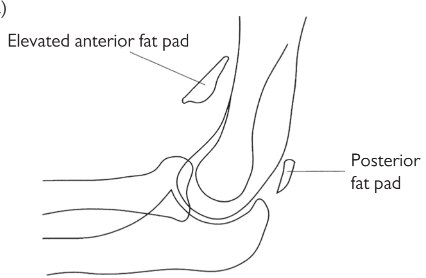
- Elbow effusion (felt as a tense, bulging swelling halfway between the lateral epicondyle and the point of the olecranon).
- The normal relationship between the olecranon and the lateral and medial epicondyles—all should form an equilateral triangle with the elbow flexed.
- Range of movement—X-ray patients who cannot fully extend the elbow and flex to touch the shoulder tip.

Elbow effusion, no visible fracture on X-ray

The presence of an effusion on X-ray (see Fig. 9.35) implies that a radial head/neck (or even supracondylar) fracture is present, even if none is visible. Provide analgesia, a collar and cuff sling, and advice regarding active movements and gradual return to normal activities. Formal follow-up is not necessary, but ensure the patient knows to return for review if the anticipated recovery timescale is delayed.

Elbow fat pad sign (See Fig. 9.35.)

(a)



(b)

Fig. 9.35 (a) Diagram of the elbow fat pad sign; (b) X-ray of the elbow fat pad sign in a 10y old child.

Radial head/neck fracture

Follow falls onto an outstretched hand (the radial head impacts against the capitellum) or direct trauma to the elbow. It can sometimes occur in combination with a wrist fracture (a dramatic example is the Essex–Lopresti fracture–dislocation (see ➔ Eponymous fractures, pp. 514–18). Examine movements—extension and flexion are usually limited, but supination and pronation may be relatively normal. Check for an elbow effusion, and palpate for tenderness over the radial head whilst supinating/pronating the elbow. X-ray usually confirms elbow effusion, but fractures may be difficult to see (see Fig. 9.36). Treat fractures with analgesia and a collar and cuff sling. Discharge undisplaced fractures with written advice about exercises and likely recovery time, with advice to return if there are any problems (see ➔ Fracture clinic and alternatives, pp. 436–7). Arrange a fracture clinic review for displaced or comminuted fractures which may require surgery. If very painful, immobilize in an above-elbow POP backslab at 90°.

Fig. 9.36 X-ray of radial head fracture.

Olecranon fracture

Follow falls onto the point of the elbow. The olecranon fragment may displace proximally due to pull of the triceps. Swelling, tenderness, or crepitus are present on examination. In the young, the olecranon epiphysis may cause confusion on X-rays (see Fig. 9.37). Treat undisplaced or hairline fractures in an above-elbow backslab POP at 90°; provide analgesia, and arrange fracture clinic follow-up. Refer fractures that are displaced or involve the elbow joint for ORIF.

Fig. 9.37 X-ray of displaced olecranon fracture.

Dislocated elbow

Assessment

Examination reveals loss of the normal triangular relationship between the olecranon and epicondyles. Check distal pulses and sensation as the brachial artery and the median and ulnar nerves may be damaged. Elbow dislocations may be classified according to the direction of dislocation and the presence of associated fractures (eg fractured coronoid). The most frequent injury is postero-lateral dislocation (ie movement of the distal part in a postero-lateral direction).

Management

After analgesia and X-ray (see Fig. 9.38), most dislocations may be reduced in the ED under IV sedation with full monitoring (see ➲ Approach to sedation, pp. 316–17). However, GA is sometimes required.

Reduction techniques for postero-lateral dislocations

- Flex the elbow to 60° with countertraction on the upper arm. Pull on the fully pronated forearm at this angle. Slight flexion at the elbow may be necessary.
- Alternatively, lever the olecranon forward with both thumbs, whilst holding the elbow flexed and whilst an assistant provides traction on the forearm.

Reduction is usually confirmed by a 'clunk' and restoration of the normal triangular relationship of the elbow landmarks. Once reduced, recheck pulses and sensation; immobilize in an above-elbow POP backslab at 90°, and X-ray again (looking for associated fractures). Consider admission for analgesia and observation for possible significant limb swelling. If unable to reduce, refer for reduction under GA.

(a) (b)

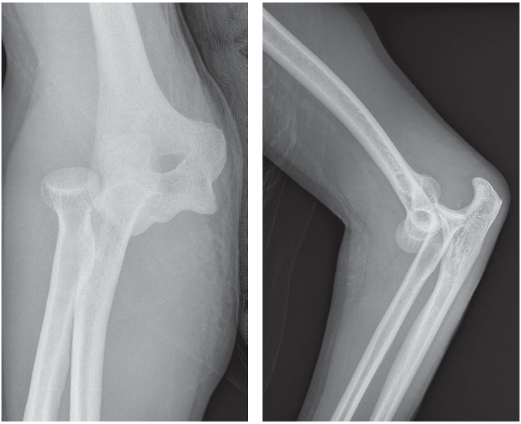


Fig. 9.38 X-rays of postero-lateral elbow dislocation.

Other elbow injuries

Supracondylar fractures

These are most common in children (see ➲ Supracondylar humeral fracture, p. 748) but also occur in adults. The elbow may be grossly swollen and deformed, but the normal triangular relationship of the olecranon and epicondyles is characteristically preserved. Check distal pulses and sensation carefully, as the brachial artery, ulnar, median, and radial nerves can all be damaged. Immobilize in an above-elbow backslab POP, and give analgesia. Refer to the orthopaedic surgeon, as MUA/ORIF are usually required.

Fractures of the capitellum occasionally occur in isolation. If undisplaced, treat conservatively with analgesia and POP. Refer those with displaced fractures for specialist treatment (possibly ORIF).

Medial collateral ligament injury

Instability on stress testing of the medial (ulnar collateral) ligament implies a significant injury. Treat in backslab POP, with the elbow flexed to 90° and supported in a sling. Arrange fracture clinic follow-up.

Other elbow injuries

Elbow injuries are relatively common in children—see relevant pages:
- Supracondylar fracture (see ➲ Supracondylar humeral fracture, p. 748).
- Lateral and medial condylar injury (see ➲ Elbow injuries in children, p. 750).
- Pulled elbow (see ➲ Subluxation of the radial head ('pulled elbow'), p. 750).

Shaft of humerus fracture

This results from a fall onto an outstretched hand or onto the elbow, or occasionally from excessive twisting (eg arm wrestling). The fracture may be obvious and palpable. Check distal pulses, the radial nerve, and the elbow joint. X-ray reveals a transverse, comminuted, or spiral (see Fig. 9.39) humeral shaft fracture.

Provide analgesia and support the fracture (eg in a POP U-slab from the axilla down to and around the olecranon and up the outside of the upper arm—apply with the elbow flexed to 90°, and hold in place with a bandage). Alternative treatment includes a 'hanging cast' POP (above-elbow POP at 90°—the weight of POP and the arm holds the fracture in a satisfactory position). Refer if displaced, comminuted, or angulated or if neurovascular complications are suspected. MUA and internal fixation are required in these cases.

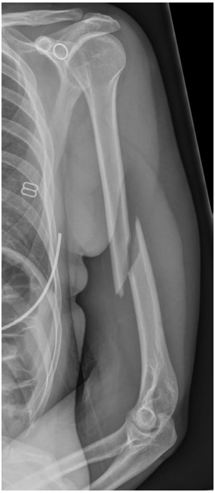


Fig. 9.39 X-ray of spiral humeral shaft fracture.

Soft tissue elbow/arm problems

Injuries to the biceps and brachialis

Inflammation of the biceps and/or brachialis at the site of attachment at the elbow can cause persistent symptoms—treat with rest and NSAID. The biceps brachii can rupture either at its long head in the bicipital groove or near the elbow insertion. Distal ruptures are sometimes treated conservatively, but some benefit from repair—arrange orthopaedic review to consider this.

Ruptured long head of the biceps

The long head of the biceps can rupture at its proximal insertion after lifting or pulling (see ➲ Soft tissue elbow/arm problems, pp. 466–7). This may follow little force (and with little pain) in the elderly. Look for the ruptured biceps muscle as a characteristic abnormal shape and low biceps bulge above the elbow on attempted elbow flexion against resistance. Treat with initial analgesia and support in a sling, followed by later exercises. Surgical repair is rarely indicated.

Lateral epicondylitis

This is commonly called 'tennis elbow'. It follows repetitive or excessive stress to the origin of the forearm and hand extensor muscles at the lateral epicondyle. It can occur spontaneously but usually follows repetitive lifting, pulling, or sports (eg as a result of an incorrect backhand technique in tennis). Inflammation, oedema, and microtears occur within the extensor insertion.

- *Look for* localized swelling, warmth, or tenderness over the lateral epicondyle and immediately distal to it.
- *Examine movements*—dorsiflexion of the pronated wrist against resistance will reproduce symptoms.
- *X-ray* if the problem follows an acute injury. Refer to the orthopaedic surgeon if there is an avulsion fracture.
- *Treat* with analgesia (preferably an NSAID) and ice application. Support the arm in a broad arm sling and advise rest, followed by progressive exercise and avoidance of aggravating movements. If symptoms are recurrent or prolonged, refer as steroid injection, forearm clasp, physiotherapy, and occasionally surgery may help. Current evidence suggests that corticosteroid injection may provide short-term relief, but long-term benefit remains unproven.

Medial epicondylitis

Often called 'golfer's elbow', this condition has a similar pathophysiology to lateral epicondylitis—it is frequently seen in racket sports and golf.

- *Examine for* localized tenderness and swelling over the forearm flexor insertion at the medial epicondyle. Flexion of the supinated wrist against resistance will reproduce symptoms. There may be ↓ grip strength, and ~60% of patients have some symptoms of associated ulnar neuritis.
- *Treat* as for lateral epicondylitis.

Olecranon bursitis

Inflammation, swelling, and pain in the olecranon bursa may follow minor trauma or occur spontaneously. Other causes include bacterial infection (sometimes following penetrating injury) and gout. Elbow movements are usually not limited. Look for overlying cellulitis, wounds, and systemic symptoms, and check for ↑ T° (these suggest infection). Consider aspiration of the bursa under aseptic conditions—immediate microscopy for crystals or bacteria may confirm gout or bacterial infection. Aspirate using a small needle at a shallow angle, and try to aspirate the bursa completely.

Non-infective bursitis Provide analgesia and NSAID, and rest the arm in a broad arm sling. Consider compression and intermittent ice application. Symptoms should resolve with rest over a period of weeks. Rarely, persistent symptoms require surgical excision of the olecranon bursa.

Gout bursitis Treat as for non-infective bursitis. Arrange follow-up through the patient's GP.

Infective bursitis If there is evidence of an underlying infection, treat with rest and NSAID and start antibiotics (eg flucloxacillin or clarithromycin). Occasionally, infection requires referral to the orthopaedic surgeon for surgical drainage.

Olecranon bursa haematoma A history of blunt trauma to the olecranon, followed rapidly by 'golf ball-sized' swelling over the olecranon, but with a full range of elbow movement (and no evidence of fracture), implies a haematoma in the olecranon bursa. Treat conservatively—attempts at drainage may result in secondary infection.

Nerve compression

Ulnar nerve entrapment at the elbow ('cubital tunnel syndrome') is the second most common upper limb nerve entrapment (median nerve compression in carpal tunnel syndrome is the most common). Refer these chronic conditions back to the GP.

Acute radial nerve palsy Above the elbow presents with sudden wrist drop, following a history of compression (eg crutch use, falling asleep with the arm over the back of a chair). The underlying injury is usually a neurapraxia, which has the potential to recover completely, given time, with conservative measures. It is crucial to ensure that flexion contractures do not develop in the meantime—provide a removable wrist splint; advise regular passive wrist exercises, and refer for physiotherapy and follow-up to ensure recovery.

Osteochondritis dissecans

This can affect the elbow and cause locking of the elbow joint. X-rays may reveal a defect and/or loose body. Refer to the orthopaedic team.

Anterior shoulder dislocation

This is a common injury, which typically results from forced external rotation/abduction of the shoulder. The humeral head usually dislocates to lie anteriorly and slightly inferiorly to the glenoid. Patients often present supporting the affected arm with the uninjured arm.

The diagnosis is usually obvious on examination. Look for:

- Step-off deformity at the acromion with a palpable gap below the acromion.
- Humeral head palpable anteroinferiorly to the glenoid.
- Evidence of complications—check especially for distal pulses and ↓ sensation over the lateral aspect of the shoulder (the 'regimental badge' area) supplied by the axillary nerve.

Give analgesia and support in a temporary sling. X-ray before reduction to exclude associated fractures. X-rays show loss of congruity between the humeral head and the glenoid. The humeral head is displaced medially and inferiorly on an AP shoulder X-ray.

Treatment

Reduce under sedation/analgesia, with full monitoring, using one of the methods described in the next sections below. The choice of technique is personal and depends partly upon familiarity. Apply minimal force to prevent humeral fracture or further soft tissue damage. In patients with habitual recurrent dislocation (and in a significant proportion of other patients as well), reduction may be easily achievable with minimal use of drugs [eg Entonox® or methoxyflurane (Penthrox®) alone]. Take time and perform the manoeuvre slowly. Note that in situations where IV sedation cannot be used or needs to be avoided, intra-articular lidocaine is an option.

External rotation method

This simple technique has a good rate of success. With the patient reclining at 45°, slowly and gently (without force) externally rotate the shoulder to 90°. If the dislocation has not yet reduced, forward flex (elevate) the shoulder slowly.

Modified Kocher's method

Lie the patient back almost flat, and once sedation and analgesia are adequate:

- With the elbow flexed to 90°, slowly externally rotate the shoulder. Pause if there is any resistance and continue only when muscles relax.
- Slowly adduct the upper arm across the chest, with the shoulder still held in external rotation.
- Once adducted as far as possible, internally rotate the shoulder by flipping the forearm towards the opposite shoulder.

Reduction may occur at any time during the manoeuvre—success is more likely if the patient is relaxed (avoid traction) and if initial external rotation reaches 90°. A 'clunk' or return of the normal glenoid contour confirms success.

Modified Milch method

Slowly abduct the straight arm to 110°. With the elbow extended, apply gentle steady traction to the arm, whilst an assistant controls movement of the humeral head back into the glenoid.

Other techniques

Scapular manipulation With the patient lying prone, 'manipulate' the scapula onto the glenoid by pushing the inferior tip of the scapula medially and the superior part laterally.

Stimson's technique A more traditional method with the patient prone. Apply a weight strapped to the forearm/wrist of the affected side as it hangs down and await reduction.

Hippocratic methods Many techniques have been described over many centuries but are probably of historical interest only.

Post-reduction After reduction, recheck pulses and sensation (including axillary and radial nerves), and obtain a check X-ray. Immobilize in a collar and cuff and body bandage. Local policy sometimes includes shoulder immobilization webbing or braces as standard. Provide analgesia (eg co-dydramol) and arrange follow-up. If unsuccessful or difficult or if the shoulder has been dislocated for >24hr, refer for reduction under GA.

Fracture–dislocation of the shoulder

Most involve fractures of the greater tuberosity associated with anterior dislocation of the shoulder (see Fig. 9.40). Reduce under sedation, as with uncomplicated dislocations—in most cases, the fracture will reduce satisfactorily, along with the dislocation. However, refer large or complex fracture–dislocations involving the humeral head, neck, or shaft.

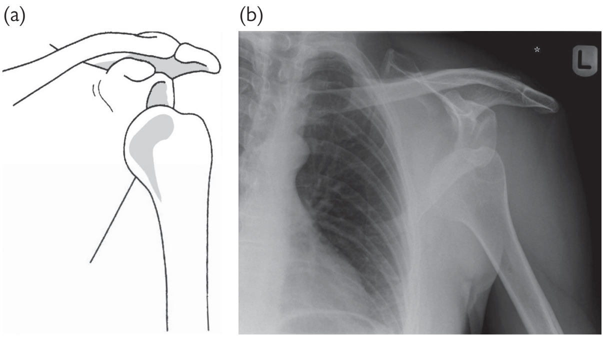


Fig. 9.40 (a) Diagram of anterior dislocation of the left shoulder; (b) X-ray of anterior dislocation of the left shoulder.

Posterior shoulder dislocation

This uncommon injury is easy to miss. It results from a blow onto the anterior shoulder or a fall onto the internally rotated arm. It may also occur during seizures or after an electric shock (when other injuries and medical problems may be partly responsible for it being initially overlooked). The patient presents with the shoulder internally rotated. AP shoulder X-ray may appear normal, but careful inspection reveals an abnormally symmetrical appearance of the humeral head ('light bulb sign') and loss of congruity between the humeral head and the glenoid (see Figs. 9.41 and 9.42). A modified axial shoulder X-ray (from above) or a translateral view confirms posterior dislocation. Manipulate under sedation—apply traction and external rotation to the upper limb at 90° to the body. If difficult, refer for reduction under GA. Treat and follow up as for anterior dislocation.

(a) (b)

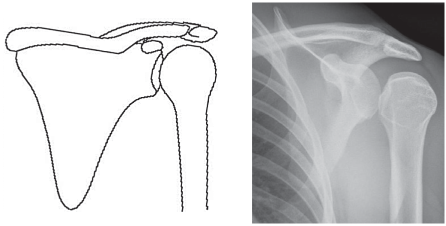


Fig. 9.41 AP view of posterior shoulder dislocation—light bulb sign.

(a) (b)

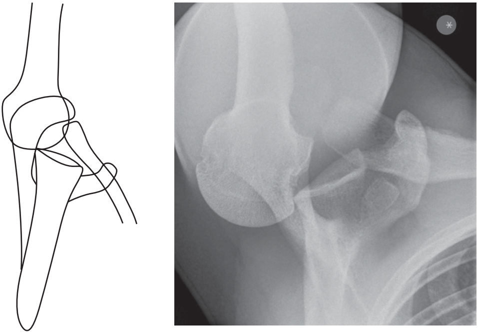


Fig. 9.42 Modified axial view of posterior shoulder dislocation.

Luxatio erecta

This is a rare inferior dislocation of the humeral head. The patient presents with the arm held abducted above the head. Check carefully for neurovascular complications. Reduce under sedation by traction in line with the abducted upper arm, followed by adduction of the shoulder. This may require reduction under GA. Treat and follow up as for anterior dislocation.

Clavicle and AC joint injuries

Clavicle fracture (See ➔ Fracture clinic and alternatives, pp. 436–7.)

This common injury results from direct trauma or from falls onto an outstretched hand or point of the shoulder. Check carefully for neurovascular complications (these are rare, but potentially life-threatening).

Treat with analgesia and a broad arm sling, and arrange fracture clinic follow-up. The vast majority of fractures unite satisfactorily with conservative treatment. Rarely, grossly displaced fractures are internally fixed.

Acromio-clavicular (AC) joint injury

These are common injuries which usually follow falls onto the shoulder. Look for tenderness, swelling, or a palpable step over the AC joint. X-rays show AC joint disruption (vertical subluxation of the AC joint by >1–2mm).

- *Grade I*: minimal separation. Only AC ligaments are involved.
- *Grade II*: obvious subluxation, but still some apposition of bony ends.
- *Grade III*: complete dislocation of the AC joint, indicating rupture of the conoid and trapezoid ligaments, in addition to the AC ligaments (see Fig. 9.43).

Treat with analgesia and support in a broad arm sling, and arrange follow-up for grade II and III injuries. These measures allow complete recovery in most cases. Occasionally, selected patients benefit from internal fixation.

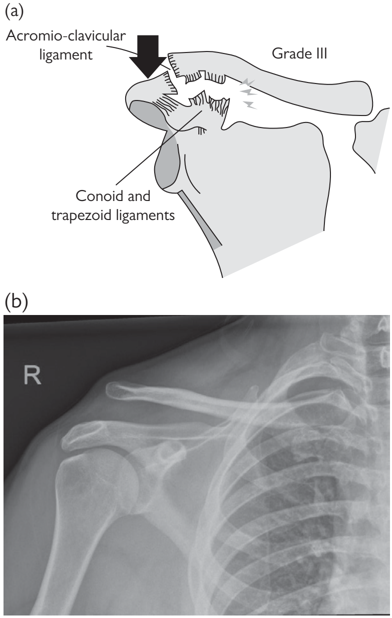


Fig. 9.43 (a) Diagram of grade III dislocation of the AC joint; (b) X-ray of grade III dislocation of the AC joint.

Humeral neck/head fracture

These result from direct trauma to the upper arm or from falls onto an outstretched hand. Examine for tenderness or swelling over the proximal humerus. Shoulder movements are usually limited by pain. X-rays typically reveal impacted or oblique fractures, with or without associated fractures of the greater and lesser tuberosities. Fractures may be classified as two-, three-, or four-part fractures, according to the number of fragments resulting (eg a fractured humeral neck combined with a fractured greater tuberosity will be a 'three-part fracture') (see Fig. 9.44).

Treat with a collar and cuff support, analgesia, and follow-up. Warn the patient to expect significant visible bruising to appear, extending down the arm towards the elbow (for this reason, it is helpful to document the lack of any clinical evidence of elbow injury at first presentation). Discuss with the orthopaedic team all comminuted, displaced, or markedly angulated humeral neck fractures as MUA and, occasionally, internal fixation/hemi-arthroplasty are indicated.

Isolated greater tuberosity fracture

Occasionally, there is an isolated fracture through the greater tuberosity, with no fracture through the surgical neck (see Fig. 9.45). Provide analgesia; treat in a sling/collar and cuff, and arrange fracture clinic follow-up.

Fig. 9.44 X-ray of three-part humeral neck fracture with displacement and angulation.

Fig. 9.45 X-ray of isolated greater tuberosity fracture.

Other shoulder injuries

Rotator cuff tears

Acute tears of the rotator cuff (the supraspinatus ruptures most commonly) usually follow chronic rotator cuff disease in patients >40y. They may follow trauma (eg fall with hyperabduction or hyperextension of the shoulder). Examine for ↓ range of movement, weakness, crepitus, and tenderness over the cuff insertions and subacromial area. Check supraspinatus strength by testing resistance to abduction, but remember that pain from the acute injury may preclude a full assessment in the ED. Look for bony avulsions on X-ray (tensile strength of the cuff exceeds that of adjacent bone). Treat suspected rotator cuff tears conservatively initially with analgesia and support in a broad arm sling, followed by exercises/physiotherapy at ~10 days. Arrange follow-up for patients with significantly ↓ range of movement—complete tears (particularly in younger patients) may require surgical repair. Inability to actively abduct to 90° at ~10 days suggests a complete tear, which will be apparent on MRI.

Scapular fracture

This usually results from direct trauma and implies a forceful mechanism of injury (see Fig. 9.46). Check carefully for associated injuries to the thorax such as rib fractures or haemo-pneumothorax.

Treat isolated fractures with a broad arm sling and analgesia, and arrange follow-up.

Fig. 9.46 X-ray of right scapular fracture.

Soft tissue shoulder problems

The extreme mobility of the shoulder is at the expense of stability which relies heavily on the rotator cuff. The rotator cuff comprises the supraspinatus (initiates abduction), infraspinatus and teres minor (externally rotate), and subscapularis (internally rotates). The rotator cuff may be injured acutely or damaged from a chronic degenerative process (eg impingement syndromes or RA).

Impingement syndromes

The acromion process may compress or 'impinge' on the underlying subacromial bursa and rotator cuff during repetitive or strenuous shoulder use. The supraspinatus and its tendon are most commonly affected. Minor impingement is associated with inflammation, pain, and loss of function and is reversible with treatment. Rotator cuff tendonitis is more chronic and can lead to degeneration or tearing of the cuff. Although rotator cuff tendonitis and degenerative tears usually occur in later life, acute tears can occur in younger patients.

Examination of the shoulder

Examine both shoulders for comparison with the patient sitting relaxed.

- *Look for* deformity of the clavicle or sternoclavicular joint, AC joint deformity (eg OA or injury), wasting of the deltoid muscle (axillary nerve damage), a step in the deltoid contour, or a gap below the acromion (subluxation or dislocation).
- *Feel for tenderness* over the sternoclavicular joint, clavicle, AC joint, subacromial area, rotator cuff insertion, and biceps tendon insertion.
- *Move the shoulder* gently in all directions to test passive movements. Test the strength of active movements.
- *Examine for* crepitus on movement, restriction, pain (note any painful arc), and weakness of particular movements.

Test sensation over the badge area (upper outer arm) supplied by the axillary nerve. Examine the cervical spine when shoulder examination does not reveal a cause for symptoms.

In suspected impingement syndromes, consider

- *Neer's impingement test*: fully abducting the straight arm will re-create symptoms.
- *Hawkin's impingement test*: hold the arm at 90° abduction and 90° elbow flexion. Rotating the arm across the body will re-create symptoms.

LA Injection of 10mL of 1% plain lidocaine into the subacromial bursa (approach just under acromion process from behind) should help the pain but will not affect the strength or range of movement, allowing assessment. Adding hydrocortisone, methylprednisolone, or triamcinolone to LA injection is useful for a first presentation of acute impingement. Note that symptoms may ↑ briefly after steroid injection. Repeated injection can precipitate tendon rupture.

Subacromial bursitis

This is an early form of impingement in younger patients. It follows unaccustomed activity or exercise. Look for a painful arc of 60–100° abduction, with dull, aching pain worse on activity. The differential diagnosis includes gout, sepsis, or RA. Treat with analgesia, NSAID, and ice. Demonstrate simple exercises (eg gentle pendulum swings and circling movements of the arm, crawling fingers up a wall). LA injection will improve pain and movement, and help confirm the diagnosis. Consider steroid injection if first presentation.

Rotator cuff tendonitis/tendinopathy

Usually a longer history and chronic pain (± sleep disturbance) in patients aged 25–40y. Examine for tenderness and crepitus over humeral insertions of the rotator cuff and ↓ active and passive shoulder movements. X-ray may show osteophytes or subacromial calcification. LA injection may ↓ pain but usually does not ↑ the strength or range of movement. Treat as for subacromial bursitis. In more severe cases, consider formal physiotherapy and orthopaedic referral.

Calcific tendonitis

A poorly understood process of calcium deposition and resorption within the rotator cuff tendon. Commoner in women. May be related to degenerative change or follow minor trauma. Most common site is within supraspinatus 1–2cm proximal to humeral insertion. Acute pain (occurs during periods of calcium resorption, granulation, and healing) often starts at rest, worsens on movement and at night. Examine for tenderness at the rotator cuff insertion. There may be crepitus, painful limitation of movement or a painful arc. The calcium deposits may be evident on X-ray.

Most episodes spontaneously resolve in 1–2 weeks. Treat with analgesia, NSAID, and ice. Immobilize briefly in a broad arm sling, but start gentle exercises (as described earlier) once symptoms allow. Arrange orthopaedic follow-up—steroid injection and/or physiotherapy and, rarely, surgical treatment may be required.

Adhesive capsulitis

A misleading term, since it is caused by generalized contracture of the shoulder capsule, not adhesions. Causes include immobilization, injury, or diabetes. More common in women and rare in those <40y or >70y. Insidious onset results in diffuse, aching pain (worse at night) and restricted active and passive shoulder movements. The cuff is usually not tender. X-rays exclude posterior dislocation (see ➲ Posterior shoulder dislocation, p. 470). Refer to orthopaedics for MUA, arthroscopy, and capsulotomy.

Other causes of shoulder pain

These include referred pain from degenerative cervical spine, C5/6 disc prolapse, brachial plexus neuritis, axillary vein thrombosis, IHD, suprascapular nerve compression, Pancoast's syndrome, and a cervical rib.

Soft tissue neck injuries

Neck injuries that do not involve fractures, dislocations, ligamentous laxity, or spinal cord damage are common. Most follow car crashes involving neck hyperextension. These injuries may be given various labels but are most simply 'neck sprains'. Patients with continuing symptoms are often referred to as having a 'whiplash-associated disorder'. MRI (which rarely changes management) reveals many to have significant soft tissue injuries.

History

Neck pain and stiffness may not appear until 12hr after injury—symptoms are typically maximal at ~48hr. Ask about other symptoms (some are relatively common), which include: headache, shoulder pain, backache, and altered limb sensation. A range of other symptoms may also occur, including: dizziness, tinnitus, vertigo, and visual disturbance.

Examination

Perform a neurological examination. In fully alert, neurologically intact patients, examine for any midline or paravertebral tenderness, muscle spasm, or deformity. If there is no midline tenderness, assess active neck movements. If there is localized bony tenderness, pain on active movements, or any neurological symptoms, immobilize fully and X-ray.

X-ray[1]

Arrange cervical X-rays (AP, lateral, and odontoid peg views) in the presence of high-energy trauma, neurological symptoms or signs, ↓ conscious level, or serious injury elsewhere. In the absence of these, do not routinely X-ray if the patient is fully conscious, has no midline neck tenderness, and can rotate the neck by 45° to right and left (see Fig. 9.47).

Check for evidence of fracture or dislocation. The most common abnormality is loss of the normal cervical lordosis (neck 'straightening')—this implies neck muscle spasm and does not necessarily indicate cervical spine injury. If the patient has severe pain or any abnormal neurology, but the initial plain X-rays are normal, consider requesting a CT scan.

Treatment

If there is any clinical or radiological suspicion of vertebral or spinal cord injury, refer urgently, maintaining cervical spine immobilization.

Treat patients in whom there is no suspicion of spinal cord or vertebral injury with initial analgesia (eg co-dydramol and/or ibuprofen) and advise GP follow-up. Leave referral to a physiotherapist for the GP to decide, based upon progression of symptoms. Avoid the use of a soft collar (the evidence is against it), but instead encourage early mobilization.

Prognosis

The rate of resolution of symptoms after neck sprains is highly variable. Many patients (>40%) continue to complain of pain, stiffness, and other symptoms for many months. It is often difficult to make a long-term prognosis within 12 months of the injury.

[1] Available at: http://www.ohri.ca/emerg/cdr/cspine.html

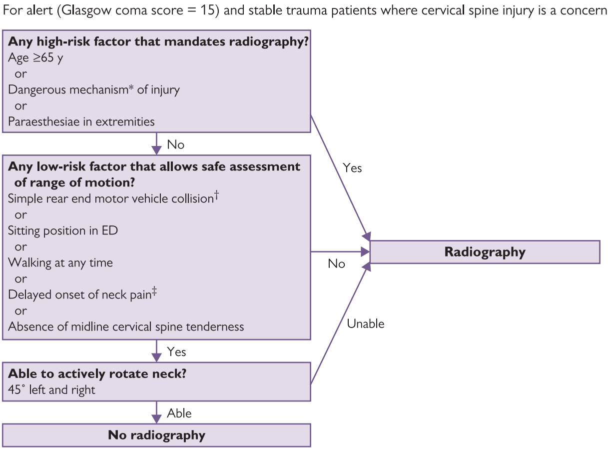


Fig. 9.47 Canadian C-spine rule. Rule not applicable if: non-trauma cases, GCS <15, unstable vital signs, age <16y, acute paralysis, known vertebral disease, or previous surgery of cervical spine. * Fall from elevation ≥0.9m (3ft)/five stairs, axial load to head, eg diving, motor vehicle collision high speed, (>100km/hr), rollover, ejection, motorized recreational vehicles, bicycle struck, or collision. † Excludes: pushed into oncoming traffic, hit by bus or large truck, rollover, hit by high-speed vehicle. ‡ Not immediate onset of neck pain.

Non-traumatic neck pain

Neck pain without injury may result from a variety of causes:

- *Cervical disc herniations*: present with neck pain and sensory and motor signs. Even if X-rays are normal, refer for further investigation (such as MRI) and treatment.
- *Acute torticollis ('wry neck')*: reflects painful sternocleidomastoid spasm, which may occur on waking or after sudden neck movement. It responds to NSAIDs, local heat (eg heat pad or hot water bottle), and (in severe cases) physiotherapy.
- *Referred pain*: eg tonsillitis/quinsy (especially in children).
- *Dystonic reactions*: eg drug-induced (see ➔ Complications of psychiatric drugs, p. 635).
- *Cervical arthritis*: including both OA and RA.
- *Spinal infection*: if there is suspicion of spinal sepsis (neck pain with fever, ↑ WCC, and/or ↑ CRP), refer for urgent MRI.

Facial wounds

(See also ➲ Maxillofacial injuries: introduction, pp. 378–9; ➲ Middle third facial fractures, pp. 380–1; ➲ Zygomatic, orbital, and frontal sinus fractures, pp. 382–3; and ➲ Mandibular fractures, pp. 384–5.)

Cosmetic considerations

These are very important. The final appearance of a scar depends partly upon the orientation of the wound and its relation to natural skin lines (modified from Langer's description), but also upon initial management. Cleaning is crucial, but do not debride with tissue excision in the ED. Consider suturing facial dog bites (see ➲ Bite wounds, pp. 420–1) and non-contaminated facial wounds up to 24hr after injury (get senior advice first). Close facial wounds in layers, using 5/0 Dexon or Vicryl for deeper layers, with knots tied on the deep aspect. Aim to remove skin sutures (interrupted 6/0 non-absorbable monofilament) at 3 days and replace with Steri-Strips™ to minimize scarring. Consider GA to treat facial wounds in children.

Damage to parotid duct/gland and facial nerve

This is particularly likely with incised wounds in the pre-auricular area. The facial nerve emerges through the parotid gland to supply the muscles of facial expression—unrepaired injury results in permanent disfigurement. The parotid duct runs transversely forward from the anterior portion of the gland, parallel and inferior to the zygomatic arch, before entering the mouth opposite the second upper molar (look for blood here, as this implies proximal duct injury). Refer for exploration in theatre if there is clinical suspicion of involvement of any of these structures.

Associated head injury

Consider head or neck injury in all patients with a facial wound.

Specific wounds

Lip wounds Oppose the vermilion border accurately (it is often easiest to do this first). Remember that even a 1mm mismatch will result in a permanent visible abnormality. Close in layers if the wound extends into subcutaneous or muscle layers.

Tongue and oral wounds Check the teeth—if any are broken or missing, consider obtaining soft tissue lateral X-rays of the lips to search for embedded fragments. Small superficial lacerations need not be closed, but close deeper ones in layers, using absorbable sutures (eg 4/0 or 5/0 Vicryl/Dexon for mucosal surfaces). Close through and through oral lacerations in layers (mucosa, muscle, subcutaneous tissue, skin).

Eyebrow wounds Do not shave the eyebrows. Exclude an underlying fracture by palpation (and X-rays, as appropriate).

Eyelid wounds Many may be sutured with 6/0 non-absorbable monofilament. Full eye examination, excluding an FB, is necessary. Refer wounds if there is involvement of the lid margin, loss of tissue, or lacrimal duct (medial canthus) or gland (superolateral) injury is suspected.

Ears Involvement of cartilage requires suturing with fine absorbable material (by an ENT specialist) prior to skin closure. Give prophylactic antibiotic cover (eg co-amoxiclav) if there is any contamination.

Langer's lines (see Fig. 9.48).

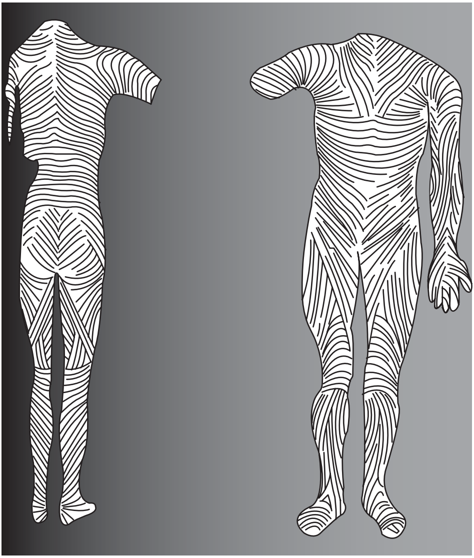


Fig. 9.48 Langer's lines.

Pelvic fractures

Major pelvic fractures result from very high-energy trauma and are true orthopaedic emergencies. Associated thoracic or abdominal injuries occur in 10–20%—the principal immediate risk is massive haemorrhage and exsanguination. Compound fractures of the pelvis have a mortality of >50%. Associated bladder or urethral damage is common. Rectal and vaginal injuries occur occasionally.

Initial assessment and management

- Resuscitate as for any severely traumatized patient (see ➲ Major trauma: treatment principles, p. 330), and arrange a trauma pan-CT scan if major trauma is suspected; otherwise, request pelvic X-ray.
- Look carefully for evidence of hypovolaemia and treat appropriately.
- Examine the pubis, iliac bones, hips, and sacrum for tenderness, bruising, swelling, or crepitus. Do not try to 'spring the pelvis' to assess stability—this is unreliable and unnecessary, and may cause additional haemorrhage/damage. Similarly, avoid log rolling patients with obvious pelvic fractures.
- Apply a pelvic binder if not already applied prehospital.
- Look carefully for wounds, especially in the perineum.
- Defer PR examination until after emergency CT. PR examination may give information on anal tone and palpable fractures, and detect bleeding, rectal tears, and urethral damage (high-riding, boggy prostate).
- Insert a urinary catheter after CT scanning (one attempt only) and test the urine for blood.
- Look at X-rays carefully for disruption of normal pelvic contours (Shenton's lines), asymmetry, and widening of the pubic symphysis or sacroiliac joints.

Classification of pelvic fractures

(See Table 9.3 and Fig. 9.49.)

Table 9.3 Tile classification of pelvic injuries

Type A	(Stable injuries) include avulsion fractures, isolated pubic ramus fractures, iliac wing fractures, or single stable fractures elsewhere in the pelvic ring
Type B	Rotationally unstable but vertically stable
B1	'Open book' antero-posterior compression fractures, causing separation of the pubic symphysis and widening of one or both sacroiliac joints
B2	Ipsilateral compression causing the pubic bones to fracture and override
B3	Contralateral compression injury resulting in pubic rami fractures on one side and compression sacroiliac injury on the other
Type C	Rotationally unstable and vertically unstable. The pelvic ring is completely disrupted or displaced at two or more points. Associated with massive blood loss and very high mortality. Subdivided into C1 (unilateral), C2 (bilateral), and C3 (involving acetabular fracture)

Treatment

Stable type A injuries require analgesia and bed rest until able to mobilize (usually 3–6 weeks). *Isolated pubic ramus fractures* are common and often missed in the elderly (particularly when the focus is on a potential fractured neck of femur). Refer to orthopaedics/elderly care team for analgesia, initial bed rest, and then mobilization.

Unstable type B and C fractures are emergencies

Resuscitate as for any major trauma (see ➲ Major trauma: treatment principles, p. 330). Correct hypovolaemia; anticipate coagulopathy, and ensure blood is rapidly available as massive transfusion may be required. Minimize movement, but support an obviously unstable pelvic fracture associated with severe haemorrhage using a pelvic binder or splint (eg SAM sling). Involve senior trauma specialists early to consider options which include reduction and immobilization using an external fixator, angiography with selective embolization, or surgical packing in theatre. Interventional radiology is very useful in patients with active arterial pelvic haemorrhage.

Avulsion fractures around the pelvis

Avulsion fractures occur at attachments of various muscles as follows:

- *Anterior inferior iliac spine*—rectus femoris (typically results from a miskick into the turf—see Fig. 9.50).
- *Anterior superior iliac spine*—sartorius.
- *Ischial tuberosity*—hamstrings.

In most instances, symptomatic treatment based upon rest (consider crutches) and analgesia suffices. Larger avulsions (particularly of the ischial tuberosity) may require internal fixation (to avoid complications such as non-union).

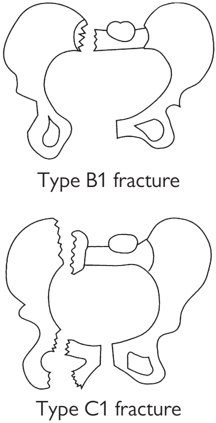


Fig. 9.49 Examples of pelvic fractures.

Fig. 9.50 Avulsion of anterior inferior iliac spine in a 15y old.