FITNESS FOR WORK

The Medical Aspects

THIRD EDITION

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Trauma

D. Snashall and B. Povlsen

Trauma is the commonest cause of death in people under 40. Limb injuries are the commonest, head and visceral injuries are the most lethal. This chapter will deal with the effects of direct trauma to limbs, thorax and abdomen. The effects of major trauma to the head are dealt with in Chapter 6 (Neurological disorders) and injury to the spinal cord is dealt with in Chapter 11 (Spinal disorders). Lower limb amputations and prostheses are also covered in Chapter 12 (Orthopaedics).

Traumatic injuries

In the industrialized world most severe injuries arise from road traffic accidents, which claim approximately 1 in 10000 lives each year. Most deaths occur within the first hour following the injury, before the patient arrives at a hospital, and brain or chest/cardiovascular injuries are the commonest causes. With improved emergency treatment at the roadside, more and more severely injured patients now reach hospital alive. Early treatment of visceral injuries and cardiorespiratory complications is ideal, with definitive treatment of musculoskeletal injuries delayed until after the patient's condition has been stabilized.

Mechanical trauma

Skin and subcutaneous tissue

Skin and the underlying fatty tissue (subcutaneous tissue) can be damaged by direct laceration (puncture, tear, or shear), by thermal injury (hot or cold) and by electrical injury. Puncture or clean sharp cuts of the skin are usually treated by primary repair following adequate cleansing and debridement. Unless there is an underlying medical condition or infection (e.g. caused by biting), repair will take place quite rapidly after opposition of the tissue edges. Sutures or steristrips can be removed after about 10 days and minimal time need be lost from work. Patients who work with food should not be allowed back to work until all wounds are healed and normal hand hygiene precautions are possible. Wet work should similarly be avoided. More extensive damage, where large areas of skin are lost, may require covering with skin grafts. These may be split skin grafts or full thickness skin grafts, depending on the depth of the injury. Special areas such as the palm of the hand and fingers may present recurrent problems, even though initial healing was successful, when the grafted or healed tissue provides inferior mechanical strength compared to the original cover—a problem sometimes for heavy tool handlers. This can lead to time off work due to secondary infections and may require later secondary surgery involving reconstruction with full thickness tissue from other parts of the body.

Muscle

Muscle may be directly severed, severely bruised, or crushed, or may be damaged indirectly as a result of trauma to the nerves or blood vessels supplying it. In cases of muscle laceration, it may be possible to restore function by direct suture, providing the blood supply is adequate. In cases of severe bruising or contusion, the muscle compartment may need to be decompressed or the muscle partly removed. Where a group of muscles is profoundly damaged, it may be possible to restore function by transferring another group of muscles into the same compartment.

The rotator cuff of the shoulder represents the most frequently damaged functional muscle unit that requires repair. This vulnerable structure runs in a bony tunnel between the humeral head and the acromion. Injuries to the shoulder therefore quite often lead to injuries of the rotator cuff resulting in muscle rupture causing persistent pain and weakness and a reduced range of motion in the shoulder. This may require surgical intervention and lead to permanent inability to lift heavy weights. (See also Chapter 12 p. 242).

Tendons

The commonest tendon injuries arise from sharp injuries to the hands. The appropriate treatment depends on whether injury is to the extensor or to the flexor tendons. Extensor tendon injuries can be treated successfully with simple repair and immobilization for approximately 4 weeks, after which an equivalent rehabilitation period will lead to an acceptable functional outcome. Injuries to the flexor tendons of the fingers require skilled surgical repair and then postoperative rehabilitation by a dedicated hand therapist. A specially designed brace is used which passively flexes the fingers by means of a pulley but allows the patient to actively extend the fingers. Such a device will be necessary for 8–10 weeks before the patient is allowed to start active flexion exercises. Full rehabilitation may take up to 3 months after the initial repair. When flexor tendon repair has been delayed, a two-stage repair may be needed using spare tendons from other parts of the body after an initial operation has created a tunnel within which the grafted tendon can slide.

Ligaments

The commonest ligamentous injuries are about the ankle; next, the knee. The commonest injuries to the knee are to the medial and lateral collateral ligaments. A more serious injury is to the anterior cruciate ligament which occurs when torsion of the body takes place with the lower leg secured, or vice versa. Two typical examples are the footballer who twists his knee or the skier who crashes. There may be a loud crack, immediate swelling, and severe pain. The injury causes instability of the knee which may lead to secondary meniscal tears. Anterior cruciate ligaments are seldom repaired or reconstructed in adults over 30 unless they are engaged in contact sports at a professional or semi-professional level, as rehabilitation after reconstruction can sometimes take up to a year. In the older age groups building up muscle strength around the knee and using stabilizing knee braces has just as good an effect but with significantly reduced rehabilitation time. No firm guidelines can be given regarding whether patients can work while on waiting lists for surgery to meniscal tears or cruciate ligament injuries. However, patients who for safety reasons require full use of their knees such as scaffolders, construction workers, and steeplejacks, or those who need to work on uneven ground, such as farmers, foresters, or emergency workers, should be directed towards less physically demanding work until surgery has been carried out. The same restrictions apply to carers who have to lift and support others. Office workers may return to work about 2 weeks after arthroscopic surgery for meniscal tears. Individuals who have physical jobs may not be able to return to work until normal muscle strength around the knee is re-established, particularly if they have been off work for a long time and developed significant muscle atrophy. With patients who have had surgery for reconstruction of ligaments a return to high physical activity may take up to a year and they will normally be required to wear a brace or plaster for 6–12 weeks after the operation.

A common site of ligamentous injury in the hand is the ulnar collateral ligament of the thumb (gamekeeper's or skier's thumb). This occurs when the ligament is stressed and subsequently ruptured due to radiovalgus trauma to the metacarpophalangeal joint. If it is completely unstable it is advisable to explore the injury and if necessary effect a repair. Postoperative rehabilitation requires 6 weeks in plaster followed by subsequent rehabilitation which can normally be carried out by the patient himself. Depending on the dominant side, lighter work tasks can be carried out even in the immediate postoperative period and also during rehabilitation depending on the requisite grip strength in the affected hand.

Cartilage

There are three types of cartilage: hyaline, elastic, and fibro-cartilage. Hyaline cartilage, which consists mainly of mucopolysaccharides, is the most common. Hyaline cartilage persists in adult life not only on the articular surfaces of joints, where it covers the opposing bone edges, but also in the supporting framework of the nose, larynx, trachea, and bronchi. Because of the mucopolysaccharides, hyaline cartilage has a very high content of water which acts as a sponge, transforming the cartilage into a buffer, and acting as a barrier to mechanical trauma. However, if damaged, it is replaced not by new hyaline cartilage but by fibro-cartilage which does not have the same mucopolysaccharide content and is therefore not able to re-establish the same good mechanical shock-absorbing qualities. This is the reason why, after joint trauma, although no injuries may be discerned initially, the joint may develop osteoarthritic changes later when the original cartilage is replaced with a less mechanically favourable type.

Blood vessels

Localized damage to blood vessels is sometimes amenable to direct repair by vascular surgery or micro-surgery. More extensive damage may be overcome by the use of bypass grafts, though not commonly, because such damage is likely to co-exist with other tissue, nerve, and bone injuries as well as with soft tissue which leads to cover problems. If severe trauma is sustained to the blood vessels, resulting in complete disruption of the blood supply to the distal limb, amputation may be required; however, most amputations following trauma are due to bone and soft tissue loss.

Nerves

The best-known classifications of nerve injuries are those of Seddon and, later, Sunderland (1951). However, these classifications do not cover ischaemic, thermal, electrical, or chemical lesions. Neither do they incorporate the important factors of viability or contamination of the surrounding tissue. For practical purposes the functional description by Seddon is the more useful.

Seddon classification

- Following mild compression injuries **neuropraxia** can occur which causes a local conduction block but no injury to the axon and will lead to almost complete restoration of function.
- If a more severe crush injury has occurred the continuity of the axon may be broken but with the immediate surrounding tissue of each nerve fibre left intact. This injury type (**axonotomy**) will lead to functional recovery as the neurone re-enters the remaining sheath after regeneration and thus will not benefit from surgical intervention. However, the functional outcome will frequently be related to the distance that the nerve cell has to cover before it reinnervates its target area. With an average growth rate of approximately 1 millimetre per day, irreversible atrophic changes may have taken place in the target organ even though the nerve itself has regenerated almost completely. The functional outcome may be minimal if, for instance, the muscles have completely wasted during such a prolonged regeneration time. Transcutaneous electrical nerve stimulation (TENS) in order to combat the muscular atrophy occurring during denervation during prolonged regeneration times has been used experimentally.
- If the entire nerve has been divided (**neurotmesis**) little if any spontaneous regeneration will occur since the distal and proximal stumps tend to move apart due to their inherent elasticity, creating a gap. Surgical repair is therefore required in order to ensure, at least the possibility of regeneration. The speed at which a nerve regenerates and grows towards its target area is considered to be the same following crush or transection and suture. However, functional outcome following crush injury is far superior to that which can be created by surgical repair, even with the most advanced techniques.

Sunderland classification

Sunderland's classification has five grades.

- **First-degree injury** corresponds to Seddon's neuropraxia.
- **Second-degree injury** corresponds to axonotomy.

Sunderland divided Seddon's neurotmesis into subgroups, depending on the continuity or discontinuity of individual connective tissue components:

- In a **third-degree injury** both axons and endoneural tubes have been divided, but the perineurium remains intact. This injury may be seen following severe compression or traction trauma and is sometimes accompanied by intrafascicular bleeding, oedema, and ischaemia.
- In a **fourth-degree injury** the axons, the endoneural tubes, and the perineurium have all been divided, but the epineurium is preserved.
- In a **fifth-degree injury** the entire nerve trunk has been divided.

Functional outcome

Several factors affect the functional outcome following a nerve injury. The best outcome is following a simple neuropraxia where the nerve fibre itself is not divided, or a crush injury which does not require surgical intervention. The least successful is any nerve injury which requires surgical intervention. The other important factor is the distance from the injured nerve to the target organ. Little if any function can be re-established following 2 years' lack of nerve supply. As the distance, in a mature adult, from the cervical spinal cord to the hand is in the region of 80 centimetres, with a regeneration growth of 1 millimetre per day the nerve-damaged hand is on the borderline as far as eventual function is concerned. Thus a significant delay in carrying out a surgical procedure may prevent a useful functional outcome even though the nerve eventually reaches the target organ. It is important therefore to establish as early as possible whether an injury has caused nerve damage requiring surgical intervention. **If surgery is necessary, it should be carried out as soon as possible.**

Age has been cited as an important factor for establishing good functional outcome following injury, but it is not clear whether this is a matter of age or size (and therefore a matter of growth distance). Experiments have not shown that young animals have superior regeneration to older ones under controlled conditions.

Hand injuries

Most nerve injuries are to the hand and therefore most often affect sensory nerves. When dealing with sensory nerves it is important to remember that the most significant disability following such injuries is not the loss of sensation but the neurogenic pain that such nerve lesions can cause. Two types of neurogenic disturbance can occur following such injuries.

- The best-known is **post-traumatic neuroma** which normally occurs when the nerve has been completely transected and the proximal stump of the nerve has separated from the distal end. This prevents the growing axons from reaching the distal stump and they form a neuroma. Even small neuromas in the upper limb can cause significant pain and functional disability. It is important therefore that such nerve injuries are explored if possible and repair effected, as this significantly reduces the chance of post-traumatic neuroma formation. If a neuroma has formed, desensitization carried out by a specialist hand therapist can in some cases reduce discomfort. Utensils or tools with special handles which reduce direct compression of the neuroma can sometimes be useful. However, in most cases where a significant neuroma has formed the best method of treatment is excision and grafting of the nerve if the distal end can be located. If that is not the case then transfer of the neuroma to a location which is less likely to be exposed to direct compression can help reduce the functional disability.

- A less common problem is **post-traumatic Raynaud's syndrome** which can occur after either crush or transection injuries. This often leads to cold intolerance which, particularly for individuals who normally work in low temperatures or wet climates, may prove to be severely disabling. There is no proven treatment for this disorder but sympathetic blockade can be attempted using oral medication. Guanethidine blockade, sympathetic stellate blockade, or transthoracic sympathectomy in well-selected patients can improve their work ability although some form of persistent disability is always found.

Specific nerve injuries (see also Chapter 12)

Brachial plexus injuries

Injuries occur in two main situations:

- Traction injuries sustained at birth. These are most frequently unilateral and fortunately tend to recover spontaneously during the first month of life. However, if permanent disability ensues, tendon transfers are preferred to nerve repair in the very young, though some centres have now started to reassess this approach.
- Later in life—particularly in the late teens—as a result of motor cycle accidents where the driver is thrown off the motor bike and sustains traction injuries on hitting the ground. Such injuries are more commonly observed now, as more motor cyclists avoid fatal head injuries by using helmets. The trend is to treat them as early as possible. Even avulsed roots can be reimplanted into the spinal cord with some functional regeneration. Brachial plexus injuries causing persistent functional disability of the hand are best treated by tendon transfers.

Peripheral nerve injuries

The axillary nerve, which innervates the important deltoid muscle, is vulnerable to traction injury during dislocation of the shoulder. This injury is usually relatively benign enabling regeneration and reasonably good functional recovery. It is best treated conservatively.

More common are injuries to the **median and ulnar nerves**. The median nerve is damaged by lacerations around the wrist, either self-inflicted as part of a suicide attempt or accidental when the patient smashes a window. Less often the ulnar nerve is injured, usually around the elbow where it runs superficially. Because this site is remote from the hand, the functional outcome following ulnar nerve injuries is often poor. However, some improvement can be achieved if the repair is carried out by expert surgeons. The ulnar nerve has a major role in the innervation of the intrinsic muscles of the hand, and the motor problems that arise in the absence of recovery cause more handicap than the sensory loss.

For both the ulnar and median nerves two types of deficit result—motor and sensory. Resultant motor dysfunction is the more sensitive to the level of the laceration. Median and indeed ulnar nerve lacerations cause similar sensory dysfunctions as the major sensory target is distal to the division of the main nerve trunk. If the ulnar nerve is divided above the elbow there will be weakness in both flexion and extension of particularly the ulnar half of the hand. If, however, the injury is at wrist level normal flexion is likely to persist but the patient will be unable to straighten the fingers. Median nerve injuries at elbow level and above will result in poor flexion of the thumb and first and second fingers, but also an inability to oppose the thumb to the other fingers of the hand. If the injury is more distal the motor dysfunction will be the same but will pose, at this level, a more significant functional disability than an ulnar nerve lesion, preventing in many cases the patient from properly gripping a pen, hammer, etc.

Median nerve laceration around the wrist is extremely disabling, particularly if the dominant hand is injured, as the patient is initially left without any sensory innervation in the most important part of the fingers. The median nerve also innervates the muscles around the thumb which enable the thumb to be brought into opposition and act as a post for the rest of the fingers. If this motor function is lost and not restored in any other way the functional deficit will be similar to the disability seen following an amputation. The lack of motor function in the thumb can, however, be compensated for if the more proximally innervated muscles of the forearm are intact as tendon transfers can be carried out especially if the ulnar nerve is intact. However, sensory deficit in the hand cannot be made up and the best option is to carry out meticulous repair of the median nerve to gain optimal sensory reinnervation. Hand rehabilitation following nerve damage is to a great extent preventive as nerve regeneration cannot be enhanced but, owing to long regeneration times, significant permanent contractures can develop which can prevent the patient from using the hand even after complete successful nerve regeneration has taken place. It is therefore important that during rehabilitation all joints in the affected extremity are treated regularly by a hand therapist. Between exercises a special splint may have to be worn ensuring the joints are placed in the most appropriate position to prevent contractures. After regeneration has taken place it may be necessary for the patient to be given a specific exercise programme in order to rebuild the strength of the affected muscles. As function has been impaired or is absent it generally takes twice as long for strength to return. Although partial sensation may have returned to the hand the input is not of the same quality as before the injury because the individual nerve cells do not grow back in exactly the same order as previously. If patients have had major sensory nerves repaired then sensory re-education may be necessary.

Limb reimplantation

Limb reimplantation is, for practical purposes only, carried out on upper extremities—usually only around the wrist and more distally. Muscles in the extremities suffer permanent damage if they are deprived of their circulation for more than 6 hours. It is possible to reimplant a whole leg and achieve survival of structures such as bone and skin, but if the muscles do not function such reimplantations often cause more disability than amputation which leaves a stump that may be fashioned for a useful prosthesis. As a result of these considerations, only whole-hand reimplantation is commonly attempted today. The intrinsic muscles of the hand may not work, but because of the function of the extrinsic long tendons and a hope of functional sensation in the hand, useful results can be achieved despite complete loss of the intrinsic muscles. Single-finger reimplantation is no longer advocated except when the thumb is involved. The reason for this is that reimplanted digits often lose their full range of movement and normal sensation. As, to all intents and purposes, a three-finger grip only is required, such patients will often avoid using such a disabled finger. Patients who have had reimplantation of a single finger have worse function than those who have had an immediate functional filling of the amputation stump. In addition rehabilitation following finger reimplantation can, due to prolonged healing problems and loss of sensation, be very long whereas revision of an amputation may enable a heavy labourer to return to work within a month with good permanent functional ability. Single-finger amputation (either right or left) should not prevent an individual returning to work. However, many-finger amputations lead to problems of post-traumatic cold intolerance which, apart from the milder degrees, does not seem to improve with time. This can also be the case even if the finger has been successfully reimplanted; quite often patients who have experienced significant limb injuries suffer as much from pain and cold intolerance as they do from actual loss of function as a result of reduced mobility in the extremity. Obviously if an individual requires, for their particular occupation, to use all five fingers of both hands, or needs normal mobility of all fingers, then such injuries can prove extremely limiting. With dominant hand injuries younger adults seem to be surprisingly able to compensate by increasingly using the non-dominant hand if only one hand is required. If both hands are required at normal strength and range of motion, such compensation cannot take place.

Upper-limb prosthesis

There are fewer than 100 upper-limb amputations per year in the UK. These amputations are carried out because of malignancy or severe trauma. A third group needing upper-limb prostheses may be children with congenital loss of whole or part of the upper extremity. Children will generally have the best foundation for useful function of their upper-limb prosthesis as they may from an early age develop the ability to use an advanced neurocutaneous electrically operated prosthesis. Such prostheses are also available for adults, but are not so successful.

The function that patients may be able to achieve with prostheses varies greatly: at one extreme is the patient who never accepts psychologically the loss of a limb and, as a result, rejects the whole concept of using a functional prosthesis and even sometimes a cosmetic prosthesis. Often, at the other extreme are younger and otherwise fully fit individuals who are able to learn how a myoelectric prosthesis works and are able to operate it with such accuracy that even complex activities can be achieved, e.g. lifting up a child using a normal hand and a myoelectric upper limb prosthesis.

Fractures

Fractures can arise from traumatic injury to healthy bone, repetitive strain to healthy bone, or during normal use of a pathologically weakened bone. Treatment depends on the nature and site of the injury.

Stress fractures

Stress fractures as a result of repetitive strain occur in sites where there is an altered blood supply, and healing may be prolonged because the body's normal healing response and the formation of callus is reduced.

Stress fractures are rare but can occur at sites repeatedly subjected to bending or twisting forces. One is the 'march fracture', so named because it occurs in soldiers, and affects the metatarsal neck. Stress fracture can occur in the navicular bone. Stress fractures of the medial malleoli are seen most frequently in runners. These injuries present with a constant ache in the foot or ankle and the fractures are often not seen on plain radiographs. The diagnosis may be made with an isotope bone scan or MRI scan. Stress fractures of the patella have been described in athletes participating in jumping sports, and similarly stress fractures of the neck of the femur are sometimes seen in young, vigorous people who run or march for long distances. Stress fractures of the upper extremity are most frequently described in the hook of the hamate in individuals who use hammers or clubs. This presents with a dull ache and an ulnar nerve neuritis may develop.

Apart from fractures of the femoral neck, stress fractures do not require surgical treatment. However, owing to the nature of the fracture they often heal very slowly and slower than an acute undisplaced fracture in the same location, i.e. the period of rest and rehabilitation usually has to be longer.

Traumatic fractures

The three most common fractures in individuals of working age are to the forearm, the femur, and the lower leg.

The first two often occur with low-energy impact. The third, of the tibia and fibula, affects either the mid-shaft as a result of a road traffic accident, or the ankle as a result of a less violent accident. Fractures of the tibia and ankle can either be treated surgically or by immobilization depending on the inherent stability of the fracture and joint congruity.

The most common fracture in the western world is that of the distal end of the radius (the Colles fracture). It is commonly treated by manipulation under local anaesthesia and a plaster cast for 4–6 weeks. However, more and more attention is being given to these fractures and they are increasingly treated by external or internal fixation in order to prevent redisplacement. During plaster immobilization it may be possible to use the fingers for light activities such as office work, etc., but not for activities requiring heavy lifting or special hand hygiene. Patients are often left with significant stiffness in the wrist which may disappear if there are no other injuries to the carpal joints and the fracture has united in a good anatomical position. However, **malunion** in a grossly deformed position or concomitant injuries to the wrist can cause chronic problems which may lead later to a need for wrist fusion in order to restore a hand which is still strong but pain-free.

The second most common fracture is of the neck of the femur which can be intra- or extra-capsular. In elderly patients intra-capsular fractures are treated with immediate hemi or total hip replacement but in individuals below the age of 50 reduction of the fracture and internal fixation may be attempted. These patients may not be fully weight bearing for at least 6 weeks. There is a risk of between 10–50% of developing avascular necrosis of the femoral head (depending on displacement) and this may require later total hip replacement. Those patients who have received a hemi or total hip replacement will have a rapid rehabilitation if they are otherwise medically fit and normally expect to leave hospital within 2 weeks. At that stage they should be partially weight bearing and have a rehabilitation programme similar to those who have had a total hip replacement for osteoarthritis.

The third most frequent fracture is to the ankle which, if minimally displaced, can be treated in plaster of Paris for about 6 weeks if no other complication has occurred, but during this time the patient will be non-weight-bearing. After the plaster is removed the ankle is usually stiff but the patient can be allowed to weight-bear if the fracture has clinically healed. They will, however, require significant time before being fully able to balance on the ankle. This may take from 3 to 6 months after the initial injury and obviously this will have particular relevance to individuals in dangerous and active industries such as construction workers. Others who have to stand or whose legs are immobilized for long periods (e.g. lorry drivers) may suffer from swelling and discomfort around the ankle. Patients who have had an uncomplicated fracture of the ankle are quite often fully mobile 3 months later, but patients who have had significant contusions to the soft tissue or to the articular surfaces may develop permanent swelling, stiffness and pain. For patients who fracture the midshaft of the tibia, uncomplicated cases take about 3–6 months to fully heal but with tibial nailing, which provides a rigid fixation of the fracture, it may be possible for the patient to walk with the aid of crutches within a week of the injury. In patients with mid-shaft femoral fractures the healing time is often between 6–12 months but if treated with intramedullary nailing they may, in favourable situations, be able to fully weight-bear within the week following the injury even though the fracture is still uniting. If infection occurs it may lead to non-union and long-delayed recovery.

Fracture of the scaphoid is common and is conventionally treated with a special below- elbow cast for 6 weeks initially but sometimes requires immobilization for up to 12 weeks. It is possible to work with such a cast if duties are light especially if the fracture is in the non-dominant wrist. However, as the thumb and wrist are completely immobilized there is significant functional restriction of the hand. Most patients after a conservatively treated scaphoid fracture, will be able to return to their full previous occupation. However, this depends on the specific requirements of the job, especially the range of movement required. Frequently, associated injuries to the rest of the carpus are sustained, most commonly ligamentous injuries which may have been ignored initially but pose problems later. If the fracture is very displaced or does not unite within 6–12 weeks a surgical procedure with internal screw fixation is necessary. In such a situation the patient will be able to resume light activities without plaster support 4–6 weeks after surgery, but heavy work should not be commenced until complete healing has taken place, as development of avascular necrosis may lead to osteoarthritis in the wrist and permanent functional disability. The outcome relates to whether the fracture heals and whether the adjacent joint function is affected.

Non-Union of fractures

It is unusual to see non-union of fractures of the upper extremity except for the scaphoid, and very severe proximal humeral fractures. As a result fractures of the upper extremity are nearly always treated conservatively with immobilization. However, problems can arise owing to loss of joint function following immobilization while the fracture heals. Sometimes these problems are lasting and lead to secondary reconstructive surgery to improve joint mobility and function.

If the fracture does not heal, disability can develop due to pain or instability. It is also possible to develop symptomless non-union, albeit rare. Most cases require reconstructive surgery to ensure that healing takes place. If a patient develops chronic non-union caused by infection or a severely impaired blood supply, then the situation may not be resolvable and permanent disability will ensue. If non-union or malunion persists for more than 1 year, resulting in a substantial impairment in the performance of day to day activities, these patients will fall within the definition of the DDA.

Fractures to the lower extremity around the ankle joint rarely lead to non-union or avascular necrosis, but may lead to stiffness and loss of function following immobilization, particularly if joint congruity has not been restored to normal. This may lead to slow progress with rehabilitation and later osteoarthritis in the affected joint.

Fractures around the hip joint have a high incidence of non-union and avascular necrosis. As a result, fractures of the femoral neck in the older patient are usually treated with a prosthesis with or without cement fixation. The procedure is in many ways similar to total hip replacement (Chapter 12). If the fracture is more distal, e.g. in the pertrochanteric region, an open reduction and fixation with a plate and screws is often carried out. In ideal circumstances full weight-bearing is allowed the following day and the patient can often be discharged from hospital within a week. More distal fractures can sometimes be treated with intramedullary nailing which enables the patient to weight-bear immediately.

Increasingly, fractures, particularly those of the lower extremities, are treated by internal or external fixation. The benefits of early mobilization after internal or external fixation greatly outweigh the remote risk of bone infection.

Burns

Burns injuries may occur in isolation or in combination with mechanical injuries or electrical injuries. The patient with extensive burns suffers a combination of neurogenic shock caused by pain and hypovolaemic shock caused by fluid loss through the burned area or second-phase oedema. The amount of fluid loss is directly proportional to the percentage of skin area burned and the depth of the burn. These injuries require specialized treatment.

Another type of injury arises from high-voltage electrical currents. These may appear trivial when first assessed, but can kill after a delay. The delayed progressive oedema of peripheral nerves, and in particular an effect on the heart's conduction system, can lead to cardiac arrest several hours after the apparent escape from serious trauma. In the absence of this complication and provided that a large amount of soft tissue has not been electrically coagulated, recovery is complete, and fairly rapid.

In many cases electric shocks from the domestic supply (240 V) cause no thermal damage to skin or deeper tissues and have no more than a possible transient effect on the cardiorespiratory system. In these cases recovery is immediate and without sequelae.

Minor head injuries

Head injuries occur in approximately 300 per 100 000 of the population every year in England and Wales. They can be divided into mild, moderate, and severe categories on the basis of the Glasgow Coma Scale (GCS), which incorporates factors such as the period of unconsciousness, post-traumatic amnesia, and the presence or absence of a skull fracture or intracranial mass. More than 90% of cases are patients with mild head injuries. These patients have a GCS of 13* or greater in the emergency department, a loss of consciousness of less than 15 minutes, post-traumatic amnesia of less than 1 hour, and no evidence of either a skull fracture or intracranial mass.

In the moderate and severe categories patients are more likely to have associated injuries and to have obvious somatic, cognitive, and affective deficits which require treatment before a return to work can be contemplated. Many patients will require the ongoing help and advice of their family practitioner and some will require the help of neuropsychologists, occupational and speech therapists, physiotherapists, social workers, and psychiatrists.

Patients with isolated minor head injuries are not so obviously in need of formal therapy before their return to work, but between one-third and one-half develop a troublesome array of somatic and psychological symptoms over the ensuing weeks or months (see also Chapter 6, p.112). Somatic symptoms include headache, dizziness, fatigue, and intolerance of noise and bright light. Psychological symptoms can be both cognitive (e.g. poor memory and concentration) and affective (e.g. depression, anxiety, emotional lability and irritability.) The majority of patients recover fully within a few months, but a significant minority are still symptomatic 6–12 months later. This grouping of symptoms is described under the umbrella term **postconcussion syndrome**. Cognitive deficits such as memory and concentration difficulties may disrupt the progression of career or education. Affective deficits such as anxiety and depression may cause domestic changes, ranging from an overprotective family reinforcing the patient's sick role, to marital disharmony and breakdown. Entering into litigation over the original injury can lead to conflict and further emotional upset with pressure to demonstrate persistence of symptoms. Directing blame at those felt to be responsible for the injury has also been found to be related to the frequency of symptoms.

Any of these complaints can lead to difficulties at work or in returning to work. This can result in repeated visits to the general practitioner, accident and emergency, or occupational health departments. Clinical examination is usually normal and the available investigations add little to the diagnosis. An understanding of the aetiology of such symptoms, and an ability to recognize factors influencing morbidity, are necessary to optimize initial management and minimize chronic sequelae.

It was originally thought that patients with postconcussion syndrome were suffering

* The higher the number the less severe the head injury.

from an 'accident neurosis' initiated and perpetuated by litigious attempts to obtain compensation for their injury. This theory has since been questioned and it is now thought that physical and psychosocial factors are more important in both causing and perpetuating the syndrome. Pretraumatic, peritraumatic, and post-traumatic factors may all contribute to the aetiology.

- **Pretraumatic factors** include age and sex, with older patients and women more likely to develop problems. Pre-existing problems such as alcohol abuse or psychiatric illness appear to induce a state of vulnerability, as do domestic and financial stressors. Susceptibility to the syndrome is also induced by recent adverse life events and ongoing social difficulties, and accidents are more likely to happen at a time when the patient is already coping with other sources of 'social stress'.
- Contributing **peritraumatic factors** include direct brain injury and attendant psychological trauma. The patient may experience extremes of fear, anger, or resentment at the time of injury which are felt again during the anxiety and depression of the ongoing syndrome. Iatrogenic factors may compound the situation and the response of the treating physician to the patient can have lasting effects on outcome. Acceptance of the patient's symptoms and reassurance about the outcome may help to foster recovery.
- In the **post-traumatic phase** psychosocial factors come into play. The patient may have to deal with the physical and psychological effects of other injuries sustained. Cognitive and emotional difficulties can adversely affect performance at work. Patients may develop postconcussional behaviour patterns such as arguementativeness, sloth, and overdependence on analgesia and sedatives. These may in fact be passive coping mechanisms developed unintentionally by the patient.

The course of the condition is variable, with patients appearing to fall into one of three groups:

- in the commonest (**acute**) group, patients are relatively symptom-free by 6 weeks after injury
- the **chronic** group still have symptoms 6–12 months after injury
- in the **symptom exacerbation** group, patients initially recover within 6 weeks but then relapse 6–12 months after injury.

Advances in neuroimaging allow for objective evidence of brain damage to be detected in patients with postconcussion syndrome. CT has revolutionized the detection of secondary brain injury (e.g. cerebral oedema, extradural haemorrhage), although it provides little evidence of primary brain damage (e.g. cerebral contusions, diffuse axonal injury). MRI is more sensitive in detecting subtle primary lesions, and can be used to identify the cause of the patient's symptoms.

Electroencephalography (EEG) and auditory brainstem responses (ABR) have also been used to confirm an organic basis for the syndrome. ABR changes appear to reflect the initial severity of injury and the chronicity of symptoms, whereas EEG changes reflect the intensity of symptoms.

Failure to recognize the presence of the syndrome and advise the patient appropriately can lead to unnecessary emotional distress and aggravate symptoms. This may lead in turn to prolongation of the illness and increased time off work. Early clinical intervention is recommended with provision of information, assessment for the presence of neurobehavioural deficits, and advice on a graded return to work and activities. Follow-up examination is advised a month after injury, probably by the patient's general practitioner. In difficult cases referral to a neuropsychiatrist or neuropsychologist may be required for out-patient cognitive-behavioural therapy, supportive counselling, and further follow-up. MRI detection of subtle lesions may help to explain the patient's symptoms, and ameliorate the emotional distress associated with uncertainty. If medication is required, antidepressants have been found to be the most useful. Occasionally the neuropsychiatric effects of minor head injury lead to permanent disability to the extent of having a significant deleterious effect on the patient's life. Work may be impossible, especially if the individual had a job requiring exceptional mental skills. Rehabilitation into a more physical job may be possible.

Thorax

The thorax is a bony cage comprising the breastbone, the ribs, and the spine; it protects vital organs, principally the heart and lungs.

Fractures of the ribs are usually caused by direct impact, such as a fall against a hard surface, and produce severe pain made worse by deep breathing. Complications occur if a fragment of a rib is displaced so that it pierces the underlying lung, causing the lung to collapse (**pneumothorax**) with or without associated bleeding (**haemothorax**). However, individuals with pre-existing chest disease will be more susceptible to pneumonia even after an undisplaced fracture, because the pain will inhibit normal chest movement. Any lung complications will require specific treatment, but simple undisplaced rib fractures will heal spontaneously.

Fractures of the sternum may occur from direct injury from the front, or vertical compression of the chest with simultaneous fracture of the thoracic spine. In the latter case, the main problem is the spinal fracture and the sternal fracture rarely requires specific treatment. When the sternum is pushed inwards it can cause direct pressure on the heart and lungs, and may need to be restored to its original position surgically.

The term **stove-in chest** is used when multiple injuries cause a complete segment of the thorax to become detached and 'flail'. This serious injury requires prompt treatment to save life because the underlying heart and lungs are compromised. The flail segment may be controlled by use of a ventilator, but if this is not possible, surgical fixation will be required.

Abdomen

The abdomen contains vital organs which can be damaged by direct trauma. Severe crush injuries cause rupture or tearing. Loss of blood may cause collapse (hypovolaemic shock) and extravasation of urine or faeces can cause infection and peritonitis. Certain organs, such as the spleen, are sometimes removed after severe injury. When the bowel or bladder is injured, temporary diversions such as colostomy or ureterostomy may be required, which can be reversed later.

The lower part of the abdomen is protected by the bones of the pelvis, which meet at the front in the symphysis pubis and attach to the spine at the back. An isolated fracture of the pelvis seldom causes any problem as there is unlikely to be any significant displacement. When the pelvis is fractured in two places, there is a possibility of displacement and injury to underlying structures. The most common complications are rupture of the urethra or bladder, and occasionally damage to one of the arteries of the leg. If the fracture passes through the roof of the hip joint (acetabulum) it can cause roughening of the joint surface and predispose to later development of osteoarthrosis of the hip.

Most abdominal and thoracic injuries require surgical exploration with prolonged convalescence depending on the precise nature of the damage and the remaining functional disability. Time off work, is, therefore, likely to be prolonged and, if recovery is incomplete, it may not be possible for an employee to return to work, especially to a manual job. **Each case needs individual assessment by an occupational physician but some patients will suffer permanent disability and impairment.**

The degree of disability must take into account travel to work as well as the workplace where adjustments may be necessary.

Amputations and congenital limb deficiencies

The last national statistics for amputations were for 1997/98. A National Amputee Database has now been established. These statistics reflect only patients being referred to the Prosthetic Centres in England and therefore do not give the full incidence of new amputations. The figures, however, allow some points to be drawn. In 1997/98, 4837 patients were seen for the first time. Lower-limb amputations are more frequent than upper-limb amputations, the ratio in 1997/98 being 18:1. The causes of lower and upper limb amputations are quite different and are shown for 1997/98 in Table 13.1. Limb deficiencies, or congenital growth anomalies, form a very small percentage of the whole. They may present as a transverse deficiency (such as an amputation) or a longitudinal deficiency, which usually presents as a shortened limb with or without an abnormal hand or foot.

In 1988, the overall ratio of male to female amputees was 1.04 : 1 and this has shown no significant change over recent years. Only 21.3% of patients are in the 20–60 year age group (working age), 60.3% being between 60 and 79 and 16.2% over 80.

Functionally, the effect of an amputation is on mobility for lower-limb amputees and dexterity for upper-limb amputees. The extent of disturbance of function depends mainly on the level of amputation; the more proximal, the greater the disturbance.

Table 13.1 Amputation by cause 1997/98 (Amputee statistical database for the United Kingdom 1997/98).

Upper limb	Number (%)	Lower limb	Number (%)
Trauma	93 (37)	Dysvascularity	2238 (49)
Neoplasia	26 (10)	Trauma	329 (7)
Dysvascularity	8 (3)	Infection	141 (3)
Infection	4 (1.6)	Neurological disorder	154 (3)
Neurological disorder	1 (0.4)	Neoplasia	123 (3)
Other causes	34 (13)	Other causes	407 (9)
No cause provided	87 (35)	No cause provided	1192 (26)
Total	**253 (100)**	**Total**	**4584 (100)**

However, it is worth noting that although one cannot walk without two legs, it is perfectly possible to do most activities with only one arm. As a rough guide, lower-limb amputees will need 6 months before returning to work and upper-limb amputees 3 months, although if the dominant arm was amputated rehabilitation may take longer.

Complications of amputation

Complications of amputation can be divided into immediate and late (see Table 13.2). Each of these complications can not only delay return to work, but can limit working effectiveness or lead to further absence, with associated social and psychological problems.

In lower-limb amputees there is an increased incidence of premature degenerative change in the joints of the contralateral limb, the knee more than the hip. In upper-limb amputees there appears to be an increased incidence of shoulder and neck problems.

In addition to these medical complications there is the inconvenience of relying on a mechanical device which itself requires maintenance and repair to provide reliable

Table 13.2 Complications of amputation and their management

Complication	Treatment
Immediate	
1. Delayed healing	
Infection	Antibiotics
Ischaemia	Vasodilators
	Angioplasty
	Sympathectomy
	Higher amputation
2. Postoperative oedema	Stump elevation
	Exercises
	Elasticated stump sock
	Mobilization on an early walking aid
3. Phantom pain	Massage
	Analgesics
	Antidepressants
	Carbamazepine/other anticonvulsants
	Anticoagulants
	Behaviour modification
Late	
4. Late changes in stump volume	Adjust or refit socket
5. Stump abrasions	Adjust socket
6. Infected epidermoid cysts	Socket fit
	Stump hygiene
	Surgical excision
7. Neuromata	Adjust socket
	Neurectomy
8. Stress on other parts of the body	

service. Individuals may require time off during working hours to attend for appointments.

Prosthetic services

In 1984 a working party was set up under the chairmanship of Professor Ian McColl to review the artificial limb and appliance centre services. Its report[6] was published in 1986 and, as a result, an interim authority, the Disablement Services Authority (DSA) was established. This authority was operational from 1 July 1987 to 31 March 1991, at which point the services were transferred to the National Health Service. Prosthetic services became part of rehabilitation medicine and are now provided by consultants in the specialty. Several new prosthetic centres were set up during the time of the DSA to make the service more accessible. New prosthetic companies were established with emphasis on local manufacture and the ability to provide all limb systems. Wheelchair services were, in the main, devolved to district clinics run by occupational therapists, providing assessments for more routine types of wheelchairs. In most regions, specialized wheelchair assessments are still available at the regional centres, most usually for those clients requiring complex or 'specialized' seating.

Rehabilitation

Rehabilitation of the amputee requires multidisciplinary teamwork. Ideally, the team (surgeon, nurses, physiotherapist, occupational therapist, and rehabilitation physician) should assess the individual preoperatively. The technique of amputation is critical, as satisfactory fitting of a prosthesis starts with the surgeon's fashioning of the stump, which must be viewed as an 'organ of locomotion'. Postoperatively the amputee will work on general muscle strength and specific stump exercises and be assisted in restoring independence in daily activities. Walking, using an early walking aid under the supervision of the physiotherapist, commences 5–7 days after amputation. The amputee is usually referred for prosthetic fitting about 3 weeks after the amputation. Rehabilitation continues following discharge from hospital, until the amputee has achieved maximum functional independence, and in the case of those of working age, has returned to suitable employment (see below).

Prosthetics

The prosthetist is the person who tailors the fit of the artificial limb or prosthesis to the individual. This is a highly skilled job and requires knowledge of traditional materials, such as leather, metal, and wood as well as an increasing range of modern synthetics such as plastics, silicone, and carbon fibre. Prosthetic joints are becoming more sophisticated; for example energy-storing feet, which incorporate elastic materials which mimic normal gait more closely, and microprocessor-controlled knee units (which automatically control the rate of swing of the calf in relation to the speed of the gait).

Upperlimb prostheses can be purely cosmetic, body-powered, or externally powered. Body-powered limbs can be adapted to a wide range of functions and very fine movements can be achieved. Servo-assisted mechanisms can augment weak muscles. Myoelectric prostheses, which are triggered by signals from muscle groups in the residual limb, are increasingly available. At present they still tend to be much heavier than body-powered limbs, are less reliable and offer relatively crude hand movement. In complex congenital deficiencies such as those in thalidomide patients, individually designed prostheses may be required.

Special work problems

A number of general and specific points should be borne in mind when advising both amputee and employer about working conditions. In general, employers should be made aware that a patient has an artificial limb. It is particularly important that adequate washing facilities can allow the amputee to attend to the limb and stump in reasonable privacy.

Lowerlimb amputees should avoid working at heights, climbing ladders, and habitually walking over uneven ground. Generally, the more proximal the amputation the more limited the mobility. Lower limb amputees may not be able to stand all day, but equally it is inadvisable to sit all day without periodically getting up and moving around. Bilateral lowerlimb amputees may need to use a wheelchair if they have stump or prosthetic problems. These employees, therefore, require wheelchair-accessible premises (see below). In the case of upperlimb amputation, there is little or no restriction on the clerical worker and manual workers can adapt remarkably well, with self-evident limitations. A full assessment by an occupational physician, including an employment evaluation, should always be performed before giving a definite opinion.

Use of walking aids and wheelchairs

Individuals who return to work using sticks or crutches experience particular difficulty with heavy spring-loaded doors (e.g. fire doors) and steps and stairs. The latter need to have at least one handrail to ensure safety. People using a walking frame generally find steps or stairs impossible to negotiate unless the depth of step accommodates the frame as well as the individual.

Individuals who require a wheelchair need suitable ramps over all steps and sills. Doorways and corridors need to be of suitable width to allow easy movement with adequate turning space. Particular attention must be given to toilet facilities. If the person has to work on more than one floor, then the use of lifts will be needed, with controls placed at an accessible height. Attention may also be required to desk heights, access to filing cabinets, and other working surfaces or furniture.

Conclusions

Despite increasing efforts to improve safety on the road, and legislation on safety at work, traumatic injuries still continue to have an impact on the working population. The majority of individuals, however, eventually return to work functionally intact.

Further reading

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