Fractures: pathophysiology, treatment and nursing care


Summary

Many nurses working in the primary and secondary sectors will care for patients who have sustained fractures. The ability to assess these patients systemically in addition to the injury is important in detecting complications and enhancing bone healing at the various stages of injury or treatment. This article describes different types of fracture and principles for their management. The nursing care of patients who has sustained a fracture is discussed from admission to discharge.

Aims and intended learning outcomes

This article aims to discuss fracture classification and assessment, treatment options, complications and nursing care for the patient who has sustained a fracture as a result of either a minor fall or major trauma. After reading this article, you should be able to:

- Define a fracture and describe some common fracture types based on their shape and mechanism of injury.
- Discuss the signs and symptoms of a fracture and list the injuries and patient groups in which these may be misleading.
- Outline the surgical and conservative treatment for fractures.
- Discuss the nursing care and management of a patient who has sustained a fracture.
- Identify potential immediate and early complications of fractures and describe the signs and symptoms of these.

Introduction

A fracture can be defined as a loss or break in the continuity of a bone (Kunkler 2002, McRae and Esser 2002, Judge 2005). Fractures refer to all bony disruptions, ranging from a small hairline fracture to a bone broken into many fragments. Patients often think that a fracture is more severe than a break, but medically there is no difference between the two terms (McRae and Esser 2002). Fractures are usually caused by trauma (Biswas and Iqbal 1998), which is either substantial as in the case of a fractured pelvis following a road accident, or minor and repeated as seen with fractures of the metatarsal bones of ballerinas or long-distance athletes. Pathological fractures occur as a result of underlying disease such as Paget’s disease, osteoporosis, osteomalacia or a tumour resulting in weakness of the bone.

Fractures are common during childhood, young adult life and in older adults (Coote and Haslam 2004). Patients with a fracture may present to primary and acute care in inpatient and outpatient departments.

Readers are encouraged to consult a general orthopaedic or accident and emergency textbook for further information as it is beyond the scope of this article to provide extensive detail of specific fracture types, treatment and associated complications.
Fracture classification

A fracture is either ‘open’ or ‘closed’. An open fracture is characterised by a wound alongside the fracture with the potential for organisms to enter the fracture site from outside. A closed fracture is characterised by the skin remaining intact. If a patient has superficial wounds that are unrelated to the fracture, it is classified as a closed fracture. The mechanism of injury dictates the fracture pattern and as such fractures are further classified according to the type, complexity and location of the break (Figure 1). Transverse The bone in a transverse fracture is fractured at right angles to the long axis, which is usually caused by a direct force in which the bone breaks directly underneath the blow (McRae and Esser 2002, Dandy and Edwards 2003). Indirect forces can also cause a transverse fracture when the bone is subjected to a pure angular force, for example when someone falls onto an outstretched hand and fractures the bones of the forearm. Because of the shape of the bone ends in a transverse fracture, it is easier to maintain alignment as the bone ends often fit together neatly. Spiral and oblique Most long bone fractures are caused by a violent twisting movement along the long axis of the bone (Dandy and Edwards 2003), resulting in the bone being twisted apart (spiral) or the fracture running at an angle of 30˚ or more (oblique) (McRae and Esser 2002). Oblique fractures are rare and are almost always radiological artefact (Dandy and Edwards 2003). Spiral fractures are less stable than transverse fractures because the bone ends are more difficult to balance against each other. In addition, the bone spikes can damage blood vessels, nerves or skin, or break off causing what is known as a ‘butterfly’ fragment (Duckworth 1995). Impacted An impacted fracture occurs when one part of the bone is forcefully driven into another. Impacted fractures often come adrift if fixation is not achieved, for example in impacted femoral neck fractures (McRae and Esser 2002). Comminuted Comminuted or multifragmentary fractures are much more difficult to manage as...
the bone is broken into two or more fragments (Dandy and Edwards 2003). This means exact anatomical reconstruction is difficult or even impossible. Comminuted fractures are most often caused by direct trauma. **Avulsion** Avulsion fractures are caused by a sudden contraction or overstretching resulting in a bony fragment being torn off by either a ligament or tendon (McRae 2006). A small avulsion fracture normally heals well with a support bandage and rest, however a larger avulsion fracture may require surgery to re-attach the bone and may be associated with tendon or ligament damage. **Crush** Crush fractures, also known as compression fractures, occur in cancellous bone as a result of a compression force. Common sites for this type of fracture include the vertebral bodies and the calcaneum following a fall from a height. These fractures are difficult to treat as there are no fragments left to manipulate back into position (Dandy and Edwards 2003). **Fracture-dislocation** Fracture-dislocation occurs when a joint has dislocated and in addition there is a fracture of one of the bony components of the joint, for example a dislocation of the shoulder joint alongside a fractured neck of humerus (McRae and Esser 2002).

**Pathophysiology of fracture healing**

Bone is the only tissue in the body that is able to replace itself. When the process occurs smoothly, bone healing is simple. The following stages occur to unite a fractured bone (Dandy and Edwards 2003):

- Immediately following injury and for the first 14 days the fracture site is filled with blood and the broken ends of the bone become necrotic. Macrophages, osteoclasts (bone resorption cells) and osteoblasts (bone building cells) invade the blood clot. At this point the fracture is mobile.
- After two to six weeks osteoid tissue develops and forms a callus inside and outside the fractured bone and ossification begins. The fracture becomes ‘sticky’ and movement is less obvious.
- Between six and 12 weeks ossification occurs, forming a solid bridge across the gap, and the bone regains some of its mechanical strength. Many patients are alarmed at the apparent deformity or swelling of bone and they should be reassured that it is a sign of a good fracture union.
- The callus matures between 12 and 26 weeks and between six and 12 months the gap between the cortical ends is bridged.
- Over the next year remodelling occurs, bony prominences become smooth and normal bone architecture is restored.

The healing process in fractures is influenced by several intrinsic factors such as the patient’s nutritional status, age, co-morbidities, medication and smoking, but fractures generally heal in eight weeks (Dandy and Edwards 2003). Fractures of the lower limbs can take up to double this time to heal, and fractures in children heal in half the time of adults (Dandy and Edwards 2003). Bone healing does not always occur without problems and the patient may have a mal-union or non-union of the fracture. These two terms are discussed under the fracture complications section of this article.

**Time out 2**

List the initial nursing interventions you would undertake to assess a patient who arrives in your clinical area with a suspected fracture.

**Patient presentation and diagnosis**

Depending on how the injury was sustained, a patient may present unconscious via an emergency team or on foot several days later. In all cases, it is important to follow the ‘A to E’ approach to patient assessment (Table 1). Patients presenting with multiple injuries should receive an early set of chest, pelvic and abdominal X-rays, with X-rays of any limb injury or injury to the skull or facial bones carried out if the circumstances dictate and allow (McRae and Esser 2002, Solomon et al 2005). For more stable patients, X-rays of the injured part are taken once assessment has been completed, analgesia administered and transfer to the X-ray department arranged. While an X-ray in most cases is able to show a bony injury, it is not able to show severed nerves, crushed muscles, ruptured blood vessels or torn ligaments, a contaminated wound, how the injury occurred or how it should be treated.
The fact that the patient has been diagnosed with a fracture does not make it the most serious injury that he or she may have sustained (Dandy and Edwards 2003) and the nursing assessment and care of patients with fractures should therefore take a systemic approach.

The physical signs of a fracture are listed in Box 1. Based on these signs and the use of radiography it is often easy to know when a bone is fractured. However, certain fractures and fractures in certain patient groups can easily be missed despite these signs. For example, unconscious patients are unable to report pain, and if there is an impacted fracture bone ends will not produce crepitus, nor will there be abnormal movement of the fracture site. Undisplaced fractures cause no deformity and if a fracture is within a capsule, for example intracapsular fractures of the neck of femur, then no bruising will be seen as a result of the capsule preventing leakage of blood to the subcutaneous tissues (Duckworth 1995, Dandy and Edwards 2003, McRae 2006).

There are a number of fractures that are often missed including impacted femoral neck fractures, facial fractures, radial head fractures, fractures of the scaphoid, seventh cervical fractures, undisplaced fractures of the pelvis and fractures of the odontoid process (Dandy and Edwards 2003). Patients are at risk of developing complications of avascular necrosis, mal-union, non-union, arthritis and a decreased functional ability if left undiagnosed.

Treatment of fractures

Despite the many different types of fracture the principles for management remain the same (Coote and Haslam 2004, Judge 2005, McRae 2006). Early management is directed towards converting any contaminated wounds to clean wounds. The main aims of fracture treatment are (Solomon et al 2005):

- Reduction – to restore normal alignment of the bone.
- Immobilisation – to ensure that the reduced position is maintained until bone union has taken place.
- Rehabilitation – either to restore normal function or to help the patient cope with disability.

**Box 1**

Physical signs of a fracture

- Abnormal movement in a limb as a result of movement at the fracture site.
- Crepitus or grating between the bone ends.
- A deformity that can be seen or felt.
- Bruising around the fracture.
- Tenderness over the fracture site.
- Pain on stressing the limb by bending or longitudinal compression.
- Impaired function.
- Swelling at the fracture site.

(Dandy and Edwards 2003)

James returns from theatre following an open reduction and internal fixation of a severe pelvic fracture. Outline your initial assessment of James and your priorities of care over the next 24 hours, providing the rationale for each step.

**Time out 3**

Reduction A clinician can achieve reduction by closed manipulation – in which the displaced bone fragments are pulled into their anatomical position – restoring alignment or by open reduction through a surgical incision.
Immobilisation

Immobilisation can be achieved by internal or external fixation devices which are available in many forms. Internal fixation involves the patient undergoing a surgical procedure and includes devices such as intermedullary nails, compression nails, plates and screws. Internal fixation is used in certain pathological fractures, when sufficient reduction cannot be maintained by external fixation, for example when fractures involve joint surfaces, when it is important to allow early limb or joint movement, or when trying to avoid long periods of immobilisation in bed (Judge 2005, Solomon et al 2005).

External fixation can be achieved through both surgical and conservative techniques and includes non-rigid methods of support (slings), cast immobilisation, skin or skeletal traction and external fixator frames.

Rehabilitation

Restoration of the upright position and early mobilisation decrease cardiopulmonary and other immobility associated complications, for example pressure ulcers, constipation and urinary stasis (Kunkler 2002). Following healing or once the fracture is stable, the limb can be mobilised and range of movement exercises can begin (Coote and Haslam 2004). Deciding on the right time to begin physiotherapy is difficult. Rehabilitation should not commence too early as this may result in mal-union of the bone, but it should also not begin too late resulting in a perfect union of bone but muscles that are unable to operate the limb (Dandy and Edwards 2003).

Nurses have a responsibility to know what rehabilitation programme patients are undergoing; whether this is fully weight-bearing, partial weight-bearing, touch-toe-bearing or non weight-bearing; and what mobilisation aids, if any, are being used, so that they are able to continue mobilising patients when physiotherapy services are not available.

Nursing care of patients with fractures

Haemodynamic monitoring

Whether a patient has experienced major trauma, undergone surgery or is admitted for ongoing assessment, the monitoring of haemodynamic status is essential to detect any existing or potential complications such as haemorrhage. The tissues must be well perfused to receive oxygen and nutrients required for healing and recovery. If haemodynamic status is compromised, irreversible tissue and organ damage may occur, eventually leading to death if causative factors are not addressed or reversed. Because of the body’s physiological response to stress and the inherent surgical risk of shock and haemorrhage, regular post-operative observations are essential to ensure safe surgical practice. The nature of the operation as well as the method of pain control will determine the regularity of these observations. Observations should include regular assessment of pulse – noting rate, rhythm and volume – blood pressure, respiratory rate, oxygen saturation, temperature, skin temperature and colour, urine output and neurological function (Pellino et al 2002).

Pain assessment and management

While pain is a useful sensation in alerting us to disease or injury, it should not be accepted as a normal and inevitable part of recovery from injury or surgery (Kitcatt 2005). Assessment of pain is essential to ensure that the correct analgesic for the condition is prescribed and administered, and that it is having the desired effect with minimal side effects (Judge 2007a). The nurse caring for the patient having sustained a fracture should have knowledge of the medications available and their actions, side effects and dosages (Nursing and Midwifery Council 2007).

Pre-emptive analgesia should be provided so that patients’ pain is sufficiently managed before and during rehabilitation sessions. Non-pharmacological methods of pain control such as positioning, distraction techniques and massage may also benefit patients (Judge 2007a).

Monitoring for complications

Nurses should have a good understanding of the potential complications associated with fractures, surgery and the immobilisation devices used so that any problems are detected swiftly and dealt with accordingly.

Management of external fixation devices

Casts

Cast immobilisation may be carried out using plaster of Paris, synthetic materials or a cast brace. Plaster of Paris, the most common method of supporting fractures (McRae and Esser 2002), will allow for some expansion. However, because scope for expansion is limited, it is usual with new fractures to apply a backslab until swelling has subsided. Plaster of Paris is heavy and takes up to 48 hours to dry. Synthetic casts dry in 20 minutes and therefore allow early weight bearing (Judge 2005). Synthetic casts are a good choice for older patients where early mobilisation is necessary.
Unlike plaster of Paris, the synthetic casts do not allow for swelling and should not be used when injury has just occurred. Cast braces can be used on upper or lower limbs and are moulded closely to the shape of the limb and fitted with hinges to allow joint movement (McRae and Esser 2002, Redemann 2002).

For any patient with a cast it is paramount that the nurse carries out the following care (Altizer 2004, Judge 2005):

- The limb is elevated to prevent oedema and aid venous return.
- The cast should not be rested on a hard or sharp surface to prevent denting as this may cause pressure on the underlying skin. Signs of pressure ulcer formation include a burning pain, offensive odour and cast discolouration, and the patient should be advised to look out for these signs and report them immediately.
- The digits should be checked to ensure that circulation and nerve conduction are not impaired (Redemann 2002, Judge 2007b). In addition, the cast should be checked both distally and proximally for tightness and/or pain. If signs and symptoms of neurovascular impairment are evident, the cast should be split down both sides (bivalved) immediately, the padding cut and a medical opinion sought.
- It is likely that the patient will go home wearing the cast and it is therefore essential that he or she is given clear written and verbal instructions on how best to care for the cast.

**Non-rigid supports**

Immobilisers, arm slings, bandages and adhesive strapping may be used either on their own or alongside another internal or external fixation device. Such supports are useful to elevate the upper limb to limit swelling of the hand and fingers; to provide firm support which will help to limit swelling and oedema, and restrict the spread of a haematoma; relieve or limit pain as a result of the restriction in movement; and aid healing through minimising movement of the reduced fracture (McRae and Esser 2002, Redemann 2002).

The use of bandages and adhesive strapping can constrict a limb, and assessment of the digits and proximal and distal ends of any supports must be carried out to detect compromise.

**Traction**

Traction is the application of a pulling force with a counter traction force applied in the opposite direction. There are numerous types of traction and for the purposes of this article the commonly used methods of skin and skeletal traction are discussed. Skin traction can be applied by strapping the patient’s affected limb and attaching weights calculated on the patient’s body weight. Skeletal traction involves the insertion of a pin through a bone, with weights attached to the pin by a cord. Heavier weights can be used in skeletal traction, making it the preferred option for long-term management (Lucas and Davis 2005).

The use of traction has diminished with the increased use of surgical internal and external fixation (Schoen 2000). Specific care for patients in traction includes (Schoen 2000, Redemann 2002, Judge 2005, Lucas and Davis 2005):

- The traction system must be checked during every shift to ensure traction and counter traction are maintained, and that the cords and pulleys are in good working order. Weights should hang freely off the floor.
- Skin traction should be removed at least daily for limb washing and skin inspection.
- Depending on local policy, corks may be required to be placed on the ends of a skeletal pin to prevent patients from injuring themselves, and patients should be advised not to touch the pin or pin sites.
- Skeletal pin sites should be checked regularly for signs of infection and cleaned daily.
Neurovascular assessment should be carried out regularly.
Pressure area care is essential every two hours.
The patient will require general nursing care and physiotherapy to prevent deep vein thrombosis (DVT), chest infection, muscle wasting or foot drop.

External fixators Where fractures cannot be reduced using a cast or by traction – or where the patient is judged to be unsuitable for either – surgical fixation is required. The use of external fixators is now more common, especially in fractures where there is significant bone loss or extensive soft tissue damage. External fixation provides realignment, wound access and bone stabilisation of complex fractures (Kunkler 2002). The external fixator holds the bone and bone fragments by metal pins attached to an external frame, allowing access to the soft tissues, which may require skin grafting or dressing changes. There are a number of different frames that can be used depending on the complexity of the injury: monolateral, hybrid and circular.

Patients who have sustained severe injuries to their limbs may be transferred straight to theatre and wake up with an external fixator frame in place. This can have a profound effect on the patient and it is important that nurses pay attention to the psychological care of these patients, particularly with regard to acceptance of the frame and body image issues. Many patients will have a frame in situ for a number of months and concordance with treatment is essential. In addition to this psychological care the following should be carried out (Judge 2005):

- Neurovascular assessment – patients are at risk of developing peripheral neurovascular deficit. Nursing staff can detect early signs of development so that prompt treatment can be instigated to minimise the risk of deficit (Lucas and Davis 2005).
- Provision of information – patients should be given advice and support in managing the external fixator. It is also important to ensure individuals understand any benefits such as early assisted mobilisation.
- Pin site inspection and cleaning – patients are at a high risk of developing pin site infections, which may be superficial and treatable with antibiotics. However, if the infection is not treated it can progress along the pin tract to the bone with devastating effects. There is conflicting evidence regarding pin site care protocols and therefore readers are advised to consult local policy before carrying this out. Local policy and patient presentation will dictate how often pin site cleaning should be carried out, and pin site inspection must be undertaken at least daily. Where possible, patients should be encouraged to undertake pin site cleaning to help towards acceptance of the frame.

Complications of fractures
The complications associated with fractures can be classified as immediate, early or late (Table 2). Nurses must observe for complications and take preventive measures.

Immediate complications Patients with a fracture are at risk of internal and external haemorrhage because of the highly vascular structure of bone (Duckworth 1995, Dandy and Edwards 2003). Besides the blood loss from the fractured bone, the sharp bone ends found in a spiral or comminuted...
fracture, for example, may damage the surrounding muscle or blood vessels, resulting in severe blood loss into the soft tissues. Close haemodynamic monitoring of the patient is required to detect early signs of impending hypovolaemia.

One of the essential functions of the musculoskeletal system is to support and protect soft tissue structures such as the brain, heart and lungs. Without this protection, there is the possibility of injury to these internal organs. A broken rib can lead to a pneumothorax or ruptured liver, a broken skull carries with it the potential for brain damage and a fractured face or mandible an obstructed airway. Likewise, there are several injuries that carry the risk of damage to particular arteries, for example damage to the aorta from a fourth or fifth thoracic fracture, the femoral artery in fractures of the femur and the brachial artery in supracondylar fractures of the humerus in children (Dandy and Edwards 2003). These immediate complications highlight the importance of a thorough patient assessment using the ‘A to E’ approach discussed earlier.

**Early complications**

Some of the early complications to which a patient may be exposed are listed in Table 2. It is beyond the scope of this article to discuss all of these and their nursing management in detail and the reader is therefore encouraged to seek additional information on these complications. The following focuses on those complications that are of particular importance to fractures rather than discussing more general complications of immobility, even though these are also important.

A fat embolism is an uncommon but serious complication. A patient with a fat embolism is at risk of death from a relatively simple transverse fracture of the tibia if it is not detected. The cause of a fat embolism is uncertain, but it may be caused by circulating fat globules being released from the fracture site (Duckworth 1995, Dandy and Edwards 2003). Fat emboli usually occur between three and ten days after a fracture to a long bone and the patient may become confused or experience a change in mood, drowsiness, tachypnoea or respiratory difficulty as a result of progressing hypoxia (Dandy and Edwards 2003). A petechial rash is seen which varies in severity and fat globules may be seen in the urine, although this is a very late sign. Because of a period of immobilisation and the effects of surgery, patients are at risk of developing DVT, usually in the immobilised leg, although it may occur elsewhere. There is conflicting evidence within the literature regarding DVT prophylaxis and the reader should consult local policy for guidance. In general, patients may receive one or more of the following: the administration of low molecular weight heparin via injection; oral anticoagulants; anti-embolic stockings; and intermittent pressure devices (Pellino et al 2002, Judge 2005). In addition, all patients should be taught to dorsiflex and plantar-flex their ankles throughout the day to keep the skeletal calf muscle pump moving and perform deep breathing exercises to make optimum use of the respiratory system (respiratory pumps), helping to reduce deficits in venous blood flow (Love 1990, Judge 2005). If a patient complains of a swollen, painful limb the nurse should be alert to the possibility of a DVT. However, this is difficult to assess because the initial injury will also cause these signs. It is important that the nurse is aware that a large percentage of DVTs occur without any associated signs or symptoms.

If a DVT is not treated and the clot breaks off it will travel to the lungs. This is referred to as a pulmonary embolism and can be fatal. The patient will present with an acute shortness of breath, pleuritic chest pain, tachycardia and tachypnoea (Coote and Haslam 2004).

A patient may be at risk of developing compartment syndrome if his or her movement has been restricted through the application of a cast or a bandage, or if the individual has undergone internal or external fixation (Pellino et al 2002, Lucas and Davis 2005). Compartment syndrome occurs when the compartments of a limb containing nerves, muscles and vasculature are crushed as a result of continuing swelling. If the swelling is not relieved, damage will ensue and the patient is at risk of amputation. Those patients having sustained trauma, particularly tibial and supracondylar closed fractures, are at risk in addition to patients having undergone planned surgery to their limbs (Judge 2007b).

Nurses play a vital role in minimising the risk of deficit and in detecting early signs of the development of compartment syndrome (Lucas and Davis 2005) so that prompt treatment can be instigated. In assessing patients for compartment syndrome the nurse should use the ‘Five Ps’ (Dykes 1993, Judge 2007b):

- **Pain** – out of proportion to what is expected of the injury.
- **Paralysis** – inability to move digits, or increased pain on doing so.
- **Paraesthesia** – altered sensation, numbness or pins and needles.
- **Pulselessness** – absence of peripheral pulses or delayed capillary refill time.
- **Pallor** – pale and cold in comparison to the other side.
Observations must be documented on an appropriate chart.

Late complications Late complications may be seen if patients return to the outpatient clinic, or are admitted for further surgery. If the patient’s bones have failed to align in the correct position they are said to have a mal-union, while if the bones have failed to unite at all they have a non-union. A mal-union may lead to osteoarthritis as a result of abnormal distribution of load leading to early degenerative change (Dandy and Edwards 2003). A delayed union can be caused by generalised disease, immobilisation or infection, and while the bone ends join it occurs very slowly. Avascular necrosis is a late complication that may take two years to develop. If a fracture interrupts the blood supply to the bone the affected bone will die, collapse and the joint is destroyed, leading to pain and stiffness (Solomon et al 2005).

Conclusion

Patients can sustain a fracture at any time in their life and may require admission as an inpatient or be treated conservatively in the emergency department and then discharged with appropriate follow up at a fracture clinic or from their GP. A good understanding of the mechanisms of bone healing and fracture management is essential to ensure that patients receive holistic care to enable fracture healing and a safe discharge. While many of the complications discussed in this article are rare, it is important that nurses have an awareness of potential problems and can carry out a systematic patient assessment to identify and treat complications rapidly should they occur. The impact of a fracture on a patient’s functional ability should not be underestimated and appropriate advice and assistance should be arranged NS

References


