# SKELETAL TRAUMA IN TROPICS

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SECOND EDITION

JAYPEE

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CHAPTER

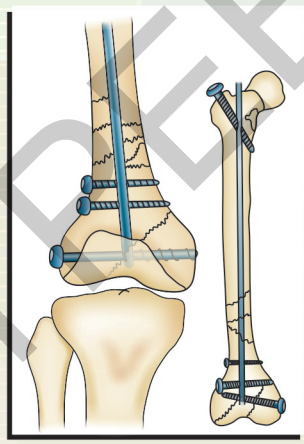
# 3

# Treatment of Fractures and Dislocations

*"Success is never final and failure is never fatal. It is courage and honest indulgence that count"*
*"Our life is frittered away by details—simplify, simplify"*

**Henry David Thoreau**

*"The Ideal fracture treatment should not focus on bone union at the expense of function, but should address itself principally to the restoration of the full function including that of soft tissue and adjacent joints. A deformity or a pseudoarthrosis is relatively easy to address in the presence of good soft tissue condition and function. On the other hand, soft tissue scarring, obliteration of the soft tissue gliding planes and joint stiffness often lead to permanent disabilities. Beauty is bone deep only when it is nicely, softly and smoothly covered"*





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## GENERAL CONSIDERATIONS

Born to Vishwamitra, Acharya Sushruta is known as the father of plastic surgery and the science of anaesthesia. His major work "Sushruta Samhita", considered as the encyclopaedia of surgery, describes 300 types of operations including treatment for twelve types of fractures and six types of dislocations. He used 125 types of surgical instruments mostly made from jaws of animals and birds.

*Sushruta*, based on his keen clinical sense and observations beautifully *classified the fractures and dislocations* (SS XI.4). He laid down the principles of fractures treatment as:

Anchana (= traction), Pidana (=manipulation), Sauksepa (=apposition and stabilization), and Bandhna (= immobilization) –(SS III 18, 19). These principles are basically true even today.

He stressed on the importance of preventing infection in compound fractures (SS IV 3.69).

It is hardly a situation when a doctor is present at the site of accident/injury. Hence, it is essential that basic assessment of the injured patient, administration of the first aid, and the method of primary splinting must be taught to as many people of the society as possible besides the general practitioners, practitioners of any "pathy", or "non-conventional treatment system" and the paramedicals, e.g. the police personnels, automobile drivers, the village level workers, drug-dealers, teachers, etc. through frequent mobile workshops, television and other media.

Injuries producing fractures, also produce damage of overlying and adjoining soft tissues—the other primary musculoskeletal tissues [the dense fibrous tissues (tendon, ligament, fascia and joint capsule), muscles, and articular cartilage]. Hence, management of both must run concurrently. The status of the surrounding soft tissue profoundly influences the treatment of any fracture. The *basic principles involved in the management of a fracture and/or dislocation* (diorthosis = setting of a fracture or reduction of a dislocation) consist of: (1) Quick general assessment; (2) Resuscitation or other emergency management; (3) Splinting the injured limb; (4) Definitive treatment; (5) Proper rehabilitation.

*Adequate general assessment* (especially for the vital injuries to brain, chest, abdomen, spine and pelvis, etc.) and first aid should be done at the site of injury (if possible) and at the earliest.

Fractures are more common in upper limbs than the lower limbs (in ratio of about 6:4).

Clinically suspected *fractures must be splinted* where the patient lies and in as-it-is position including *one joint above and one below*. It helps to reduce pain, to minimise the amount of bleeding at the injury site, to avoid the chances of further displacements of fracture and damage to soft tissues including the skin; to prevent severe complications, e.g. shock, fat embolism and; to make the transportation easier.

### Splintage or Fracture

Fracture must be splinted at the earliest on whatever support is available at hand such as wooden scale, cardbord, pillow, aluminium splint, plaster support, readymade plastic splint, etc.

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Sushruta (500 BC) used and advocated to use the bark of tree to immobilise the fracture.

The bark of Madhuka, Udumbara Asvattha, Palasa, Kakumbha, Bamboo, Vata or Sal trees should be used as splint.

Hippocrates (460-377 BC) advocated to use bandages impregnated with gum, resins, and waxes for supporting and immobilising the fractures.

*For a dislocated joint, the splint should extend along the entire length of bones above and below that joint.* Ideal splinting materials (e.g. POP slabs, crammer wire, aluminium splint, wooden arm and leg splints, inflatable splints) are hardly available at the place of injury. However, anything rigid or even semi-rigid can be used for splinting (e.g. wooden plank, umbrella, walking stick, firm pillow); and anything soft can replace cotton padding in between the limb and hard splinting material. For upper limb fractures, measuring scale, folded newspaper or magazines can function as workable splinting material. Injuries must be confirmed by X-ray in three planes (AP, lateral and oblique) and other investigations (if needed, e.g. CT scan). The splinted limb should be elevated, slightly higher than the patient's heart level to minimise the swelling. Repeated examinations of the splinted limb is essential to monitor the neurovascular status and their function (pulse, capillary refill, gross sensation and motor function).

Primary goal of fracture treatment is to attain anatomical reduction as far as possible, maintenance of reduction till union with stable fixation (external or internal or both) and early mobilisation to return the patients to their pre-fracture level of functions. The choice of management must depend upon the background of proper clinical audit (which basically assesses one's performance and compares current practise to standard practise).

*Manipulative realignment of the limb prior to diagnostic X-ray is only warranted, if there is severe neurovascular compromise from an angulated fractured fragment or sometimes if limb is in very crooked jumbled up position.*

If there is no other acceptable displacement (confirmed by X-ray) the same or replaced proper splintage should continue till the stage of clinical union, within-between radiological check-up to detect any in-splintage displacement, which if present should be corrected. If fracture is displaced, it requires reduction which can be done by close or open methods. All attempts should be there to *manage the fracture properly in the shortest period and with least expenses preferably by close methods,* of course with no or minimum compromise of the function and cosmesis. There are conflicting situations where the above ideals may not be achieved.

## Close Method of Treatment

### *Basic Principles*

- Manipulative reduction by traction and counter traction; and pressure and counter pressure.
- Maintenance of reduction till union of the fracture.
- Physiotherapy from the very beginning.

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## Principles of Reducing a Fracture

Only displaced fractures, and whose reduction can be held reduced need reduction. General anaesthesia should always be preferred which allays apprehension of the patient, provides adequate relaxation and painless reduction and helps in gaining the patient's overall cooperation. However, regional block anaesthesia, local anaesthesia (injecting anaesthetic agent into the fracture site under strict antiseptic care) or spinal anaesthesia (for lower limb fractures/injuries) can also be used. In children, ketamine hydrochloride can be used (as the first line agent of sedation) intravenously (in a dose of 2 mg per kg body weight) or intramuscularly (in a dose of 4 mg per kg body weight) for reducing the fracture or dislocation. It provides reliable, safe, quick and adequate sedation. However, there is always a risk of airway problems and a trained physician skilled in airway management must be available as standby.

*The process of reduction is the reversal of the mechanism of injury and aligning the displaced fragments, while the limb is kept stable and balanced, by traction and counter traction, and pressure and counter pressure.*

One basic principle—*The Gunn's law* (formatted in 1920s) should also be remembered while correcting any deformity (even produced due to fracture) which states *deformity should be recreated prior to reversing the mechanism of injury.*

Sometimes continuous traction (preferably skeletal) is essential to reduce the overlapped fragment by counteracting the strong muscular contraction forces, e.g. in fractures of shaft and trochanter of femur, etc.

*In reducing the fracture, the distal fragment is essentially manipulated* to realign it with the proximal fragment, which assumes a position dictated by the pull of the muscles and/or ligaments, and over which manipulater has hardly any control.

*Clinically the reduction is checked by* correction of the deformity and restoration of the anatomical alignment, relations, and the length. Whenever possible, close reduction under image intensifier is beneficial. Check X-ray is essential for assessing the reduction, record keeping, and for the medicolegal purpose.

*Maintenance of the reduction* is done by padded plaster cast or support, extending from one joint above and one joint below. The prominent subcutaneous bony points (e.g. olecranon, malleoli, fibular head, etc.); the superficially placed nerves (e.g. lateral popliteal nerve, ulnar nerve, etc.) and tendons (e.g. tendo-Achilles) should be protected by thick cotton pads. The first applied plaster should be changed by 3 to 6 weeks to a close fitting plaster after checking and correcting in-plaster displacements and angulation, if any. By this period, functional cast brace can be applied, wherever feasible.

In *postreduction period* the limb/part should be elevated to avoid any oedema, the free joints should be moved freely; isometric (static) exercises of the in-plaster muscles should be encouraged and the toes (and fingers) should be checked regularly for swelling, circulation and the movements.

*Fractures reduced by traction* may be maintained by it, or plaster cast, splints or any other fixator.

***Reduction of fractures is achieved by:***

I. *Indirect reduction* (such as reduction by traction)—It is the principal method of securing reduction of the fractures, which are to be treated by close methods. Indirect reduction

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with the use of the distractor (fixed to the fragments being reduced) is more efficient technique, since the distraction is controlled and much less force is required.

Indirect reduction is safer method and it also helps to preserve the blood supply of bone and the integrity of the soft tissue envelope.

II. *Direct reduction*—It is mostly by direct manipulation of bone fragments in open reduction in which fracture site is exposed by stripping of soft tissue and periosteum, which is likely to devitalise the bony fragments.

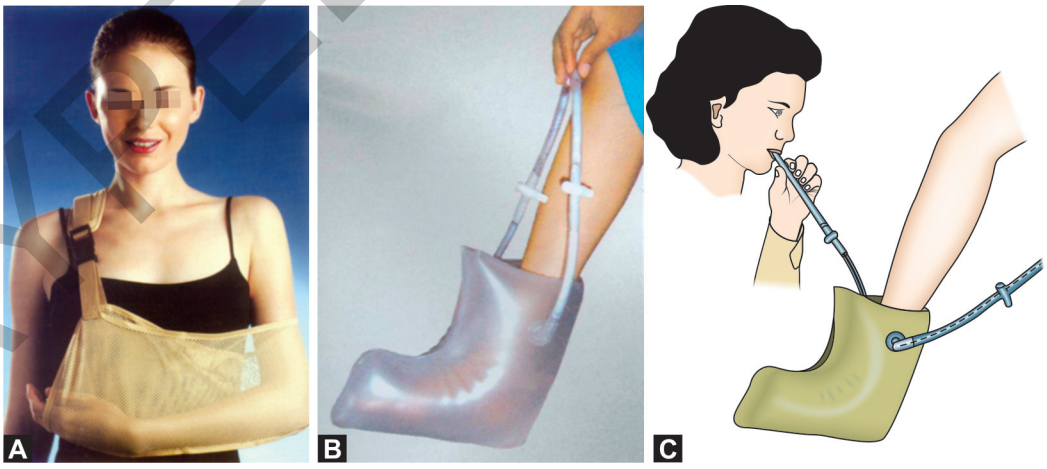
***External fixators*** (which may be straight, tubular, semi-circular or circular ring with pins or tension wires), may be used to maintain reduction. Currently, pinless fixators—pinless clips with the standard AO/ASIF tubular system are also being used.

***Maintenance of reduction*** of a fracture ideally should be by PURE splintage (P = prolonged, U = uninterrupted, R = rigid, E = extensive) if it is by external support only, but there are several fractures where such splintage is not needed.

## MODALITIES OF SUPPORT OR SPLINTS

The dictionary meaning of splint is: 'a device used to immobilise an injured part'. The term "splint" has originated from the Middle Dutch "splinte" which probably conjures up an image of two piece of wood lashed to an injured leg on a ski slope by an untrained person. There are *three general types of splints:* (a) Soft, (b) Rigid, and (c) Traction.

- ***Soft splints*** are: (a) Slings (Fig. 3.1A) and swathe or cuff and colour support—for upper limb, (b) Pillow support to the injured part of lower limb and also for upper limb, (c) Inflatable clear-plastic air-splint—once inflated it confirms to the shape of the limb and becomes stiff enough to immobilise the injured part immediately without causing excessive harmful pressure. However, the pressure inside the splint must be frequently monitored (Figs 3.1B and C).




**Figs 3.1A to C:** (A) Pouch arm sling; (B and C) Air inflated ankle-foot splint

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- ***Rigid splints*** are made of firm material and must be padded. Materials used are wooden board, cardboard, malleable metal frames, molded plastic or metal, etc. Plaster of Paris bandage are most commonly used for rigid supports.
- ***Traction splints*** counteract strong muscular forces, realign and maintain the alignments and provide effective immobilization of the fractures (See the section on plaster of Paris and traction).

## OPERATIVE TREATMENT OF FRACTURES

***The crying evil of our art in this time is the fact that much of our surgery is too mechanical, our medical practise too medical, and there is hankering to interfere, which thwarts the inherent tendency to recovery possessed by all persons not actually dying.***

–HO Thomas, 1883

As the ancient arts of bone setting and plaster immobilization gradually gave way to modern internal fixation, several principles of operative management have been widely propagated. However, in many fractures, skilfully carried out treatment by "close method" works quite satisfactorily. Mostly, it appears immaterial whether the fracture unites by primary osteonal healing or by periosteal callus, as long as it unites in acceptable position and period and the functions of the limb is restored back.

The pendulum of fracture management has shifted too far towards operative treatment, which needs definite restrain. The *most feared complications of the operative treatment is infection*. *Acute infections* occur within 6 weeks of surgery and are usually due to intraoperative contamination or bacterial colonisation of haematoma or secondary contamination related to post-operative wound problems.

*Subacute infections* also occurs due to perioperative contamination and are due to less virulent organism colonising over implant.

*Late infections* (after one year) are mostly neoinfections secondary to haematogenous or lymphatic spread from a distant source, such as urinary tract infection or dental abscess.

Further, *infection of orthopaedic implants* is a serious problem with increased antibiotic resistance of *adherent biofilm* bacteria (the colonies of bacteria in a polysaccharide matrix, collectively called a biofilm). Bacteria within the biofilms are resistant to several hundred times the bactericidal concentrations of standard antibiotics. Infective bacteria can remain dormant on surface of implant for a variable period. Local manifestations may be acute proliferation of bacteria shed by the biofilm (e.g. after fixation of a fracture) or delayed months or even years, e.g. after joint replacement when septic loosening occurs.

***Prevention of pre/peri/post-operative contamination or infection*** (mandatory to avoid disastrous complication of infection in the operative management of fracture) can be achieved by:

- Proper selection of patient—In whom the operative management is unavoidable and in whom all possible source of infection have been taken care of.

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- Proper sterilisation of operation theatre (and fumigation with ecofriendly fumigant such as stabilised hydrogen peroxide 11% with 0.01 w/v silver nitrate as a catalyst), instruments, gowns, towels, etc.
- Proper adherance to hospital's recommended policy regarding scrubbing for 5 minutes with soap-water, chlorhexidine surgical scrub, and thereafter hand rub (For example– With absolute alcohol or chlorhexidine in alcohol).
- Proper preparation of the operative field and proper draping.
- Minimising the operative exposure and time.
- Minimising the movements of persons in operation theatre.
- Strict prohibition of unwanted/unchanged persons in operation theatre.
- Pre- and peri-operative antibiotics.
- Proper haemostasis in the operative field, repeated saline wash of operative field, irrigation of broad range antibiotics in the operative field, at least where hardware is used, proper closure in recommended layers with close suction drainage, proper cleaning, dressing, bandaging and support of the part as needed.
- Minimum entry of persons (without shoes/footwear) in the patient's room.
- Post-operative antiobiotics as and when necessary.

## Significance of Diagnosis of Infection

### *Diagnosing the Inception of Infection is Crucial*

With high degree of suspicion in every case, especially where any implant has been used, repeated examination and assessments including investigations are mandatory to detect early infection, since thorough debridement and antibiotics without implant removal usually saves the situation.

In acute infection, there are stormy and pyrexial post-operative course, persistent haematoma, local warmth, oedema, pain and problems in moving the adjoining joints.

***Investigations suggested at this stage are as follows:***

- Polymorph leucocytosis has 94% sensitivity
- Raised ESR has 85% sensitivity
- Raised C-Reactive protein is another acute phase protein and has sensitivity of 96%.
- Technetium-99m bone scan is a very sensitive test for infection, but lacks specificity.

With suspicion of infection, it is mandatory to aspirate the operated zone/joint under strict aseptic condition. The aspirate should be subjected to biochemical examination mainly for protein and glucose levels (*raised protein and lowered sugar levels suggest infection*) and culture and chemosensitivity test. On cytological examination, more than 25000 leucocytes/ml fluid and more than 25% polymorphs are suggestive of infection.

## Indications of Operative Treatment of Fractures

- Unstable fracture in which close reduction has failed.
- Displaced epiphyseal fractures which, if left, can cause disturbance in growth (Salter Harris, Types III and IV).

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- Displaced pathological fractures, especially in metastatic fracture. Internal fixation of such fractures relieves pain, make nursing easy and diminishes the hospital stay.
- Displaced intra-articular fractures which are not reducible by close methods.
- Avulsion fractures which are not reducible by close methods (e.g. fracture olecranon, fracture patella, etc.)
- Non-union, especially of long bones affecting the function.
- Multiple fractures affecting the same limb or same bone.
- Bilateral long bone fractures.
- In displaced fracture neck femur, mainly those which are not reducible by close method, internal fixation should be done.
- Open fractures, mainly the unstable ones.
- In adults, fractures of both bones of forearm, Monteggia and Galeazzi fractures mostly require open reduction and internal fixation.
- If there is associated major arterial or complete nerve injury, internal fixation mostly facilitates in protecting the arterial or nerve repair. However, judicious application of external fixators or even traction can maintain the repair.
- Fractures in elderly patients, especially of lower limbs, should be treated by operative fixation to allow them up and about at the earliest to avoid the bed-ridden-complications.

## Contraindications of Open Reduction and Internal Fixation

- Presence of infection in the fractured bone and/or in its surroundings.
- Condition of the patient (not fit for anaesthesia or operation)
- Unhealthy scarred and adherent overlying soft tissues and skin coverage should be improved by proper plastic surgery prior to dealing with the underlying fracture.
- Grossly comminuted fractured fragments.
  Nos. 3 and 4 can be managed by external fixators.

Before embarking on operative management of any fracture one should ponder on the suggestion of O'Heanage Oglive—***the quality of a good surgeon is the one who knows when not to operate.***

## Timing of Operative Treatment of Fractures

Except for the fixations required as the life saving measures (e.g. few pelvic fractures); or deterioration of fractures (e.g. fracture neck of femur), or deterioration of general conditions of elderly patients (e.g. in trochanteric fractures) better results are obtained by operating upon the fractures (especially of long bones) after 10 to 14 days of injury. By this time, the haematoma is organising and laying down osteoid. Further clot is not drained out in the operative treatment, and the manipulation for reduction apparently serve to stimulate osteoblastic activity. However, AO fixations have been advocated to be done early before the swelling of soft tissue appears or immediately after it subsides.

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## Pre-Operative Investigation

Besides the general investigations (like total haemogram; routine urinalysis; assessment of cardiovascular, renal, hepatic and respiratory functions) special investigations should be performed as per the requirement, according to the age and disease conditions, e.g. when a decision to perform surgery for metastatic pathological fractures has been taken, it is imperative to exclude hypercalcaemia which if present must be corrected before surgery. Most of the patients with skeletal metastasis have an abnormally functioning coagulation system. Hence, analysis of activated partial thromboplastin time, prothrombin complex and platelet count should be done.

## Stabilisation of the Reduced Fractures

The first surgeon to use a plate for stablisation of a tibial fracture was Hansmann from Harmburg in 1886. Sir William Arbuthnot Lane (1893,1897,1914) of Scotland and Albin Lambotte (1907) of Belgium established the method of internal fixation of fracture tibia with a metallic plate.

Reduced fractures (by open or close methods under image intensification or X-ray control) should be stablised by internal or external fixators. Initially, Lane used wire transfixation stitches or screw, and then the plates made of German silver or steel. To avoid infection he perfected the *no touch technique*.

## Principle Involved in Fracture-Fixation

With *recent advances,* there is definite change in the concepts of treating fracture, mainly the diaphyseal ones, *from the mechanical era to the biological era.* From the concept of internal fixation for absolute stability to achieve primary union, the shift is towards biological aspects of internal fixation where healing with callus is being preferred with due considerations of soft tissue envelop, biology of bone and preservation of blood supply of bony fragments. *Absolute stability is no longer the dominant theme of internal fixations.*

To achieve good results of surgical management of long bone fractures, the following points should be kept in mind:

For *intra-articular fractures, anatomical reduction*, support of depressed and displaced fragments with well compressed grafts, and stable fixation enough to start early movements of joint are essential.

For *metaphyseal fractures, even acceptable reduction is optimum*, however proper contact and compression of fragments must be ensured.

For *diapyseal fractures, rotational and axial alignments should be restored*, limb length disparity should be corrected and adequate fixation of fragments should be done.

## Methods of Internal Fixation

Internal Fixation is usually done by

- ***Intramedullary nails*** (with or without locking), or pins or wire (see later on page 81).

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- ***Screws:*** The following terms are used to describe a screw-
  The *screw has a head,length and a tip*. The *pitch* of a screw is the space in between the threads.

The *lead* is the distance through which a screw advances in one turn. The screw has two diameters in its length- *thread diameter* (breadth from the edge to edge of a thread) and *core diameter* (the diameter at the depth of the pitch).

**Types of Screws**

Screws are mainly of three types:

- *Machine screw* in which whole length is threaded. It can be self-tapping or may require precut-threads for insertion.
- *ASIF screws* are usually non-self tapping, and their threads are more horizontal. They are of *three types.*
  i. *Cortical screw (Fig. 3.2):* It is threaded in its entire length. Their thread diameters are 4.5, 3.5, 2.7, 2 and 1.5 mm. For commonly used 4.5 mm, thread-diameter screw the pilot hole is drilled with a 3.2 mm drill bit, the thread is precut with a 4.5 mm tap, and then the screw is inserted.
  ii. *Cancellous screw (Fig. 3.3):* They have larger threads spread in two lengths, i.e. 16 or 32 mm and rest of the screw length is smooth. Diameters available are 6.5 and 4 mm. Rigid fixation cannot be attained in elderly patients with osteoporosis. However, cancellous screw fixation can be augmented with hydroxyapatite composite resin (CAP) as well as polymethyl-methacralyte (PMMA) cement.
  iii. *Malleolar screw (Fig. 3.4):* It is basically a cancellous screw of 4.5 mm thread-diameter and 3 mm core-diameter and with a self-tapping trephine tip.
- *Cannulated screw (Fig. 3.5):* After drilling by a cannulated drill, over a guidewire used to fix the reduced fragments, the cannulated lag screw is screwed.
- *Wood screw:* Wood screw has a tapering sharp point. It has no thread in the neck region. It can be used without drilling the hole. It is mostly used in the cancellous bone.
- *Lag screw:* A simple way to compress two fragments of bone together is by using a lag screw, which exerts intrafragmental compression. Lag screws have to be inserted into the centre of bone fragments and at right angles to the plane of fractures.
- *Specific screw (Depuy-Johnson and Johnson):*
  i. *Fusion and reconstruction system (FRS) screw*: Headless, self-tapping and self-drilling cannulated titanium compression screw
  ii. *Twist-off screws*: Used for fixing osteotomies of lesser metatarsals. It automatically breaks off as solid fusion is achieved.
  iii. *Snap-off compression pin (SOC pin):* Used for fixation of small bones of the hand and foot in fusion procedures.
  iv. *Non-locking screws:* Reduce and compress.
  v. *Locking screws* (Fig. 3.6) are inserted to hold everything in place and improving construct strength against bending and axial loading.

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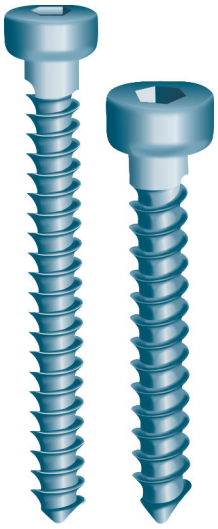

Fig. 3.2: Cortical screw

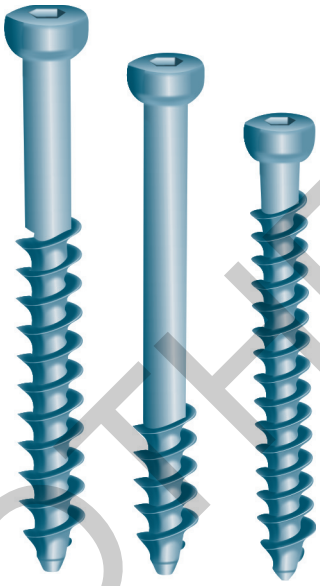

Fig. 3.3: Cancellous screw




Fig. 3.4: Malleolar screw

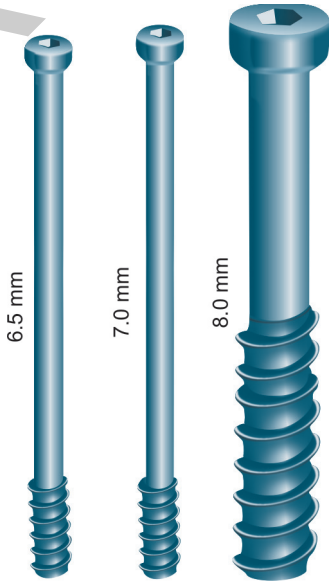


Fig. 3.5: Cannulated screw

- **Cerclage wiring:** Bernger-Feraud was perhaps the first to describe open cerclage wiring of the tibia in 1870, followed by Putti Parhern and Arbuthnott-Lane and others. Encerclage by SS wire or vittalium wire or nylon straps (tensioned by a gun and locked) with intramedullary or extraperiosteal nylon plates may be used for oblique spiral

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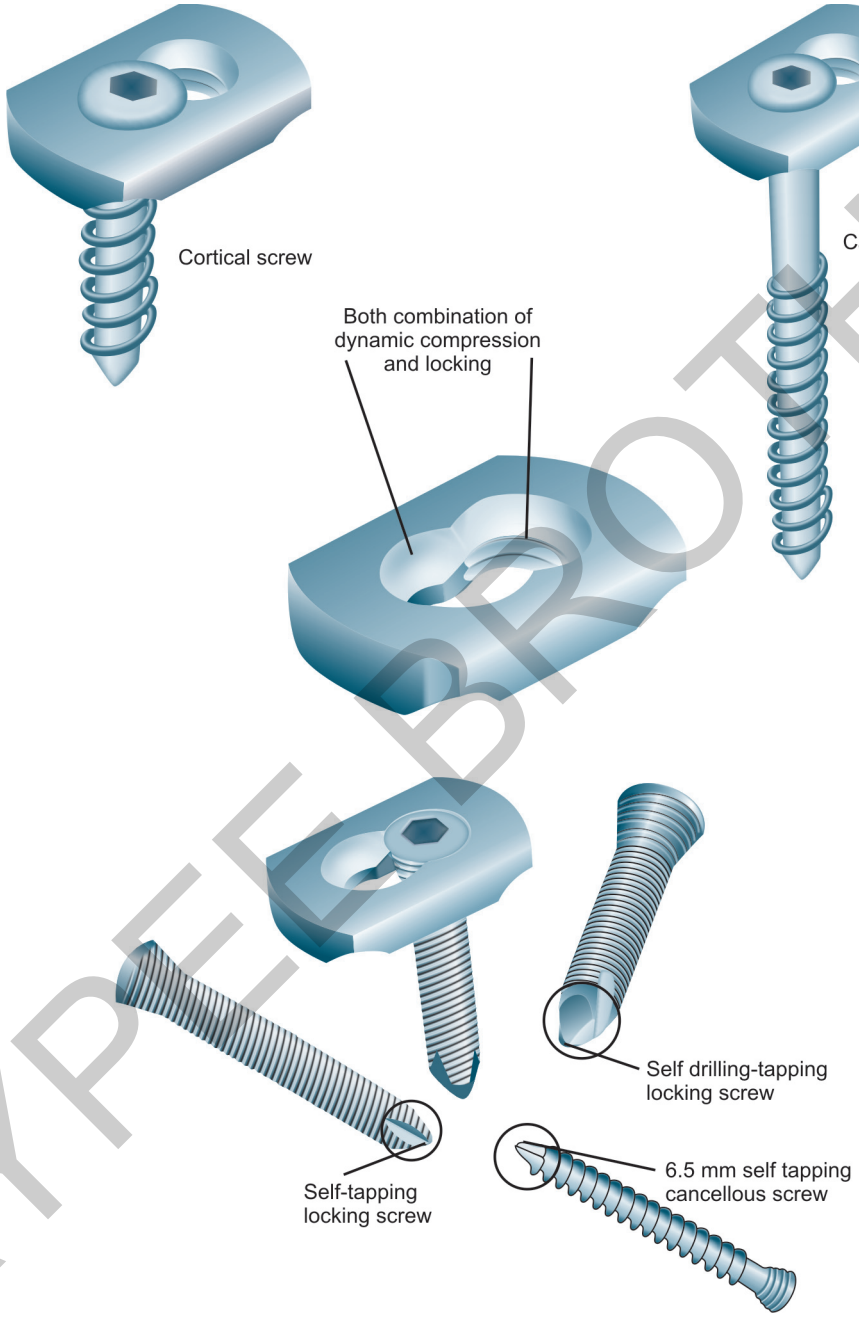


**Fig. 3.6:** Locking screws

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***Salient Features***

- Orthopaedics including trauma is more or less same all over the globe with little variation, however, treatment modalities may defer widely depending upon social culture and traditions, economic condition, geographical terrain, etc.—these aspects have been taken care of throughout in the book.
- Each chapter has been revived and updated with relevant information.
- Each chapter begins with hidden moral message.
- Atttempt has been made to present the outcome of treatment modalities through photographs of clinical results and postoperative X-rays.
- Small synopsis boxes containing gist of that portion of the text has been added wherever needed.
- Line drawing of relevant skeletal anatomy of the particular chapter has been added in the beginning of the concerned chapter for quick appraisal.
- Line drawing of relevant devices used for fixing the fracture has been given in the concerned chapter for proper understanding.
- To acquiant with the ancient Indian surgery especially the orthopaedic concerns, a small write-up has been added about the great ancient Hindu Surgeon—Suśruta.

**Sureshwar Pandey**
Has a brilliant academic career with more than 40 years of teaching experience. His several publications have been quoted in different books of the world. He has been selected as the 'International Teacher' to conduct courses in different countries.

He has contributed commendable extraordinary chapters in various encyclopaedic books published in UK, USA and India. He has authored several books, one of which has the Japanese as well as American edition. He has also contributed exhaustive chapters for the encyclopaedic books written by the International team of experts and published by Churchill Livingstone, UK and Martin Dunitz, UK. Lancet commented on his chapter in a book. "...among the many excellent contributions, the chapter by Pandey is outstanding and cover ground which will be hard to find elsewhere..."

He is the visiting professor of several universities in Japan, Australia, and Indonesia. He has been the Chairman of the Scientific Sessions, Guest of Honour, Presidential Guest Lecturer and Special Guest Lecturer invited, several times during the World International Congresses in different countries. Throughout his long and distinguished career in India and abroad, he has been on the founder editorial board of two international journals published from UK and Italy. He is the founder editor of an international journal. For his outstanding social work and volunteering services to the handicapped people, he has been awarded on national level with a BJMF National Award.

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Best Book Award (2009-10) for his book *The Clubfoot Revisited*

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