Bones fractures : types and imaging

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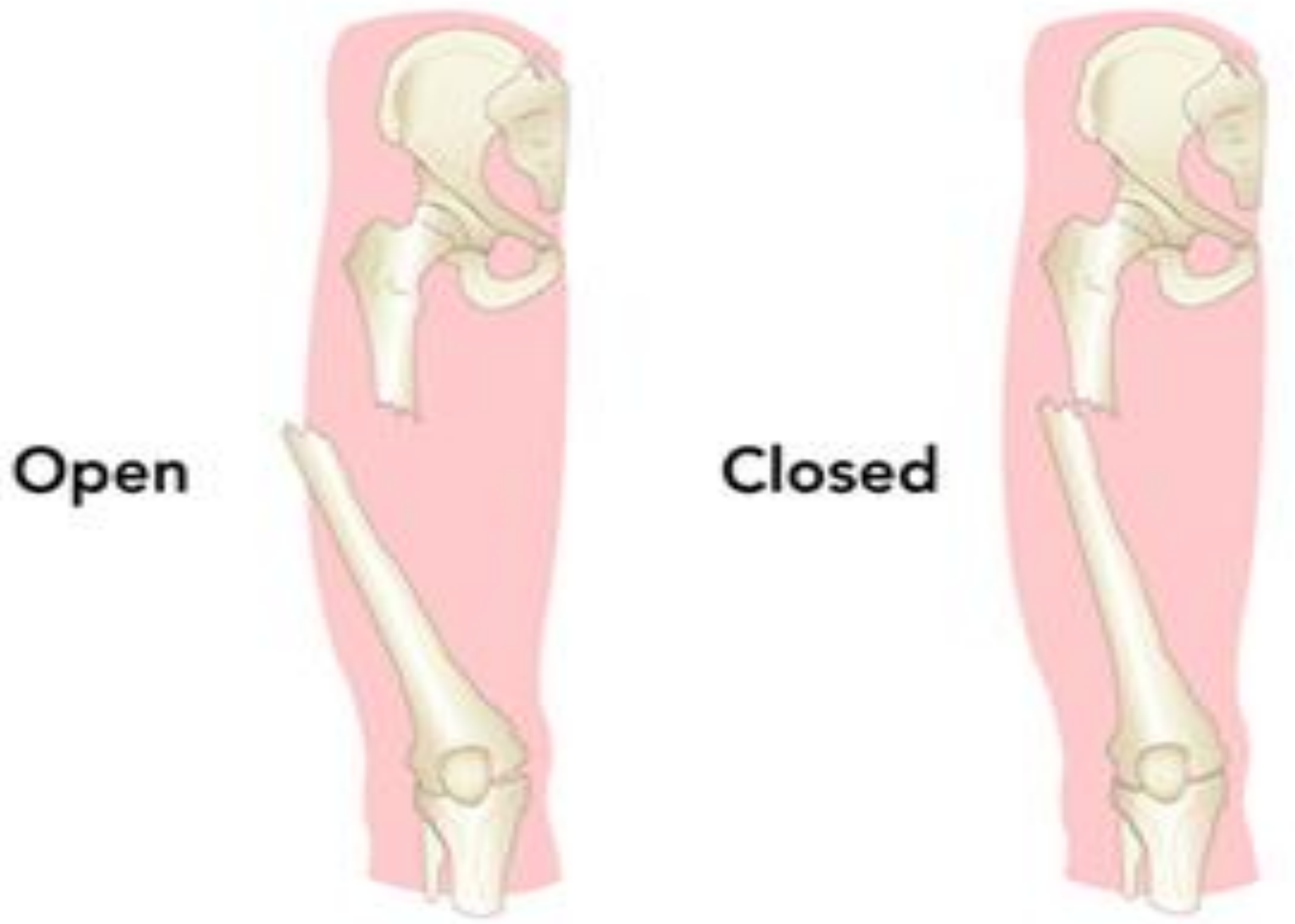
Bone fractures classification

Fractures are usually classified by:

- **Whether they are in communication** with the skin surface (open or compound) or not (closed)
- **Their appearance on x-ray**
- **Anatomical site:** for example, intra-articular involving the joint surface; metaphyseal, epiphyseal or diaphyseal.


Open
Closed

Bone fractures classification

Their appearance on x-ray

A. complete fracture: extends all the way across the bone (most common)

- Transverse fracture: perpendicular to the axis of the bone
- Oblique fracture: oriented obliquely across the bone
- Spiral fracture: helical fracture path usually in the diaphysis of long bones
- Comminuted fracture: more than two parts

B. Incomplete fracture: does not cross the bone completely (usually encountered in children), bowing fracture, buckle fracture: the cortex is buckled, often in the distal radius, greenstick fracture: the cortex is broken, but only on one side

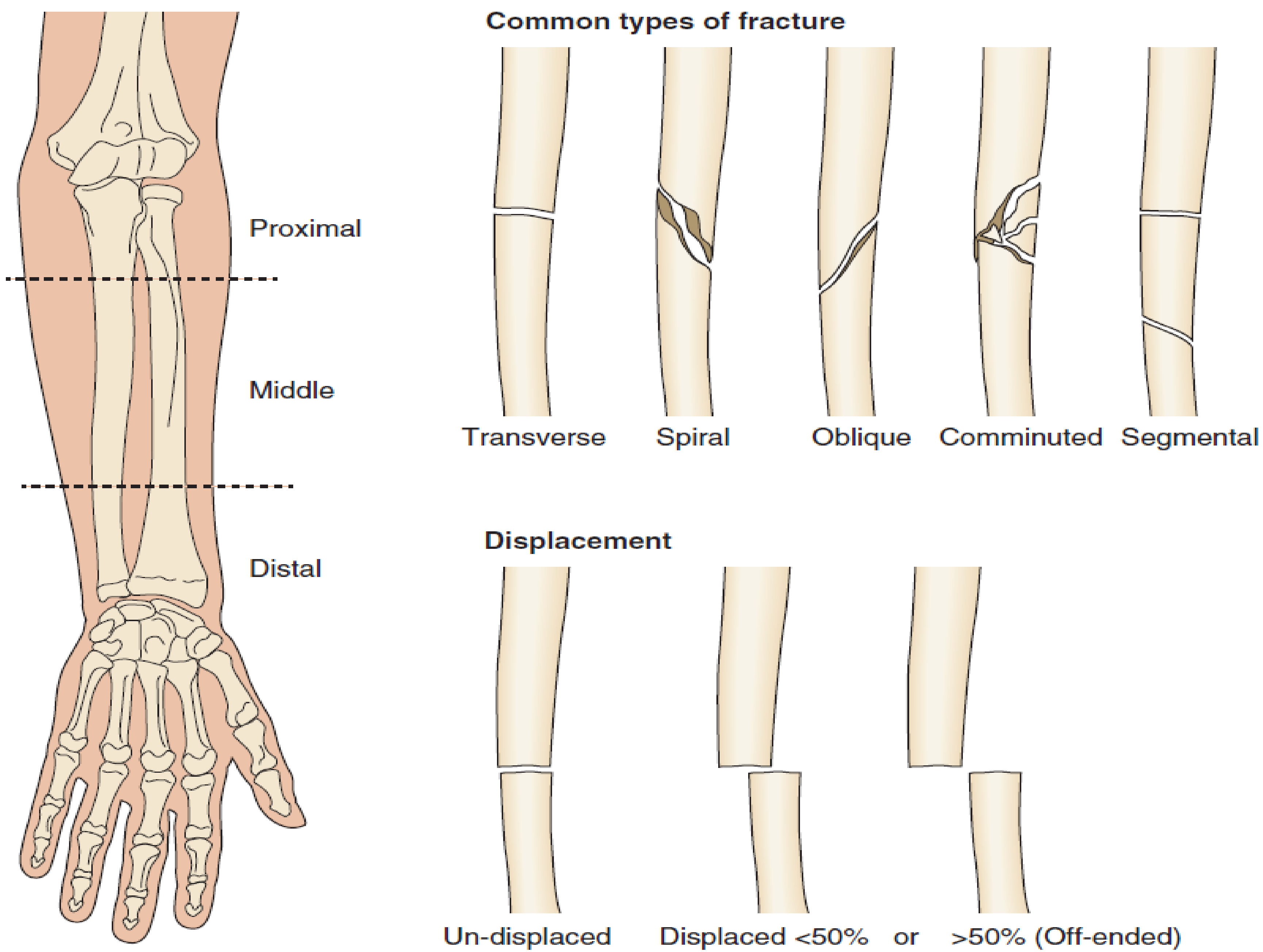
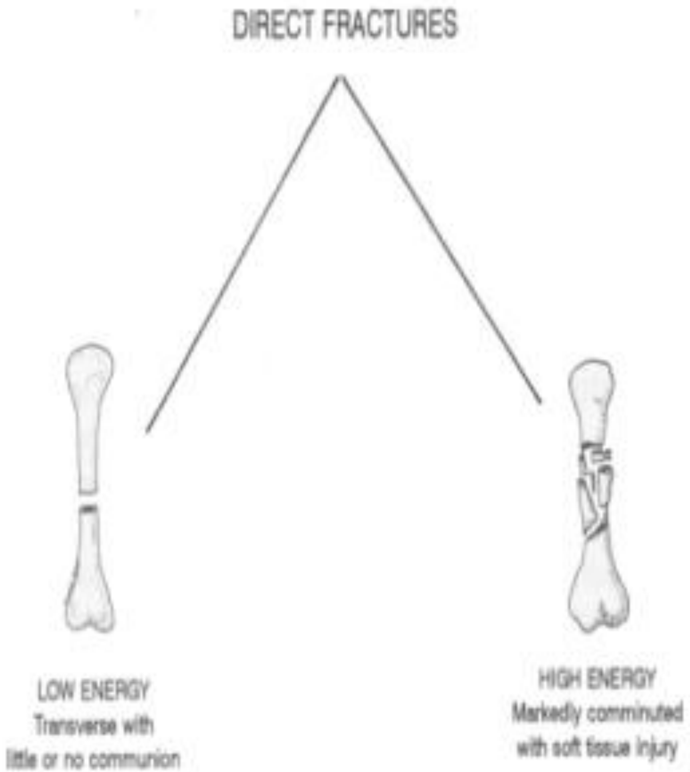
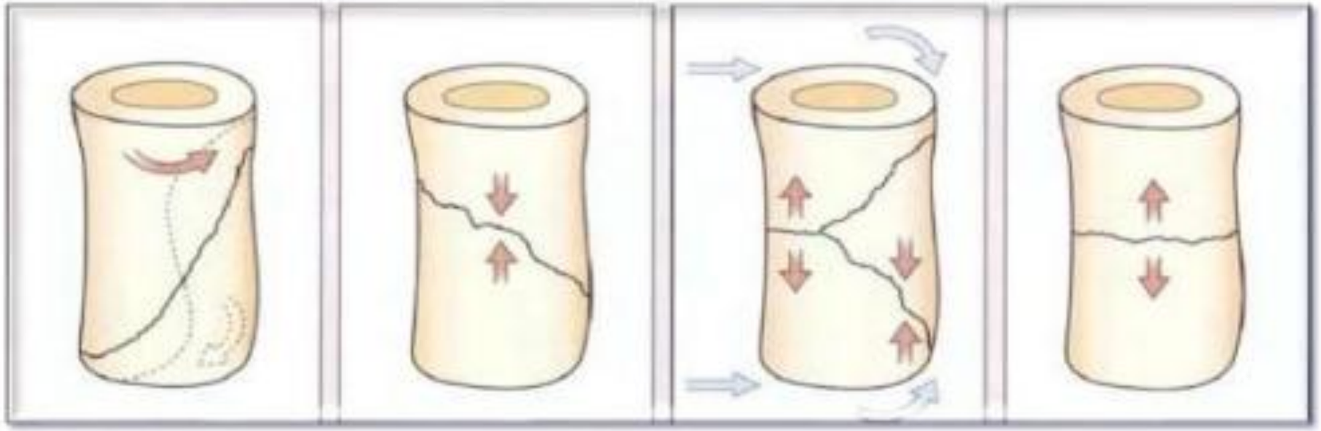


Fig. 27.28 The location and description of many common fracture types.



MECHANISMS OF FRACTURES - INDIRECT

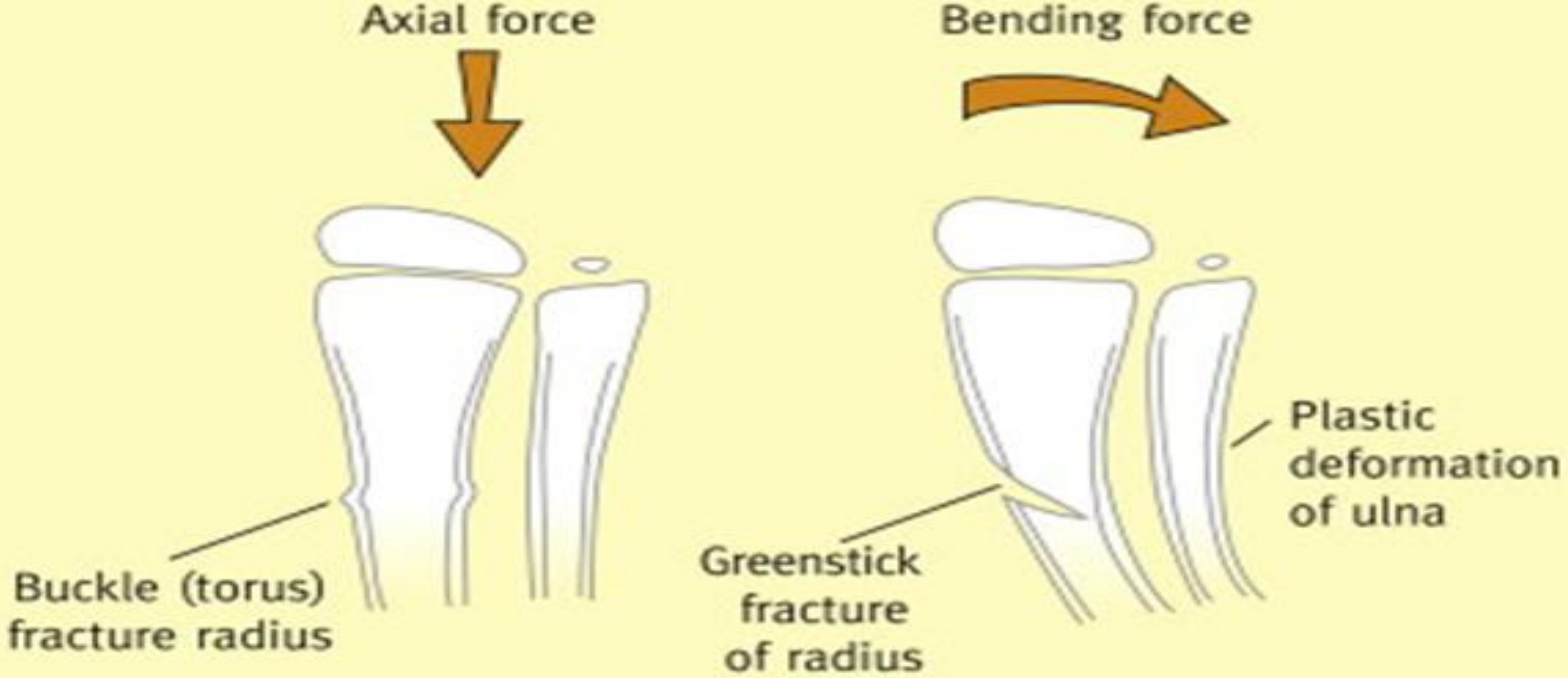


- Twisting causes a spiral fracture;
- Compression causes a short oblique fracture;
- Bending results in fracture with a triangular 'butter-fly' fragment;
- Tension tends to break the bone transversely

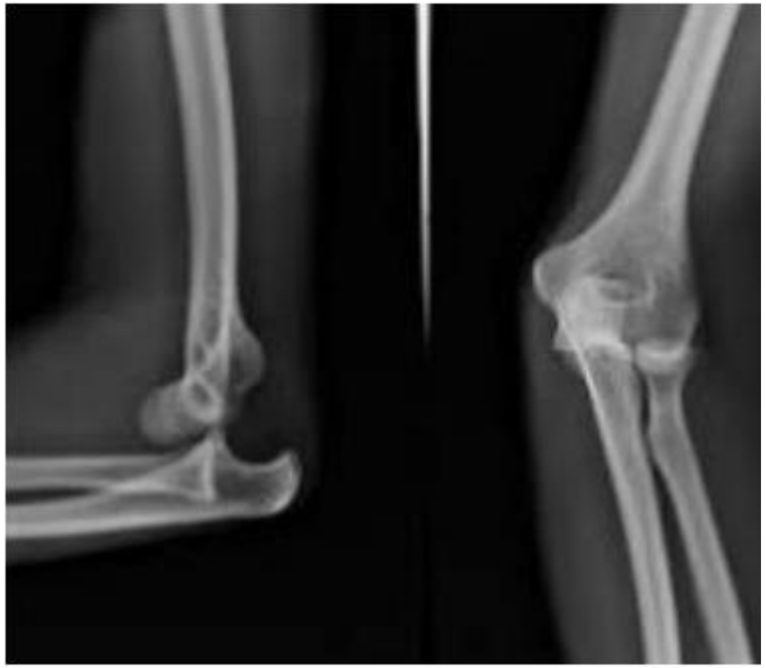
Fractures in Children

- Fractures often behave **differently** in children. Because their bones are more **pliable**.
- Children may suffer from **greenstick** fractures, in which the cortex of the bone does not break but **bends** instead.
- There may be buckling of a single cortex of the bone (**torus fracture**).
- Injuries around the physis or growth plate may lead to **growth arrest** or deformities due to damage of the growth plate.
- Generally, fractures **heal** much more **quickly** in children.

Paediatric fracture patterns




Buckle
fracture

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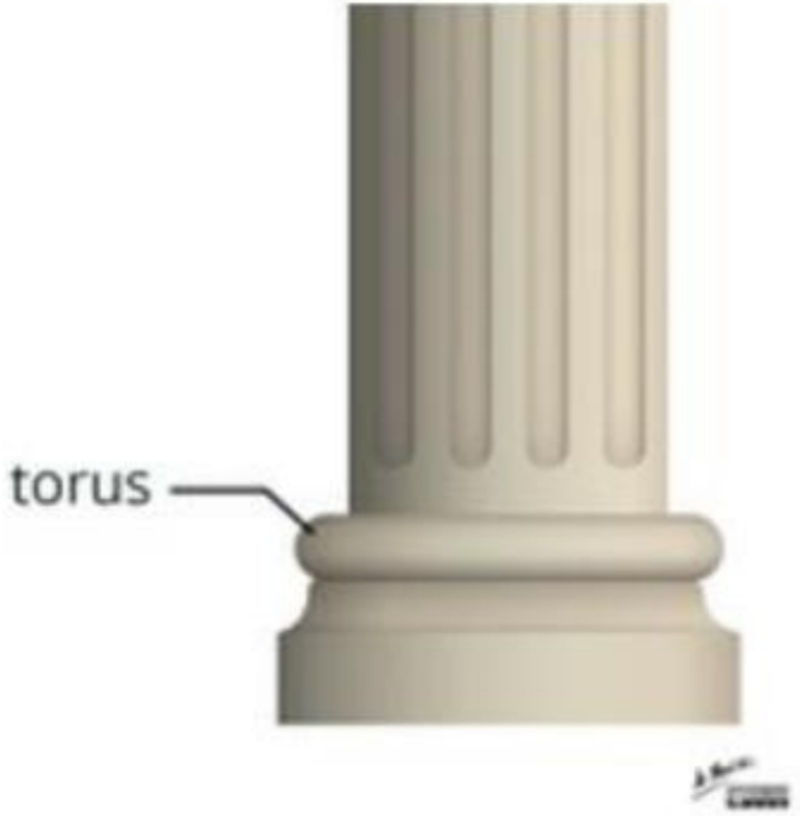
incomplete fractures

Bowing fractures

incomplete fractures

Torus fractures (buckle fractures)



incomplete fractures
greenstick fractures

Principles of fracture healing

There are many differing ways of treating fractures. However, they all have the same fundamental objectives:

The close approximation of uncontaminated, well-vascularised bone ends in a stable configuration that will maximise bone and soft tissue healing without deformity or loss of function.

In general, the fracture-healing process takes approximately 8–10 weeks in adults but can take longer depending on the severity of the injury and whether it is an open fracture.

Phases of healing:

Inflammatory phase: torn periosteum, Blood clots in the torn periosteum in the fracture line and an inflammatory reaction

Reparative phase: Granulation tissue replaces clot, Periosteum forms an immature callus, Internal callus forms within granulation tissue and Cartilage forms around the fracture.

Remodelling phase: Woven bone in the callus is replaced by compact bone (cortex) and cancellous bone (medullary cavity).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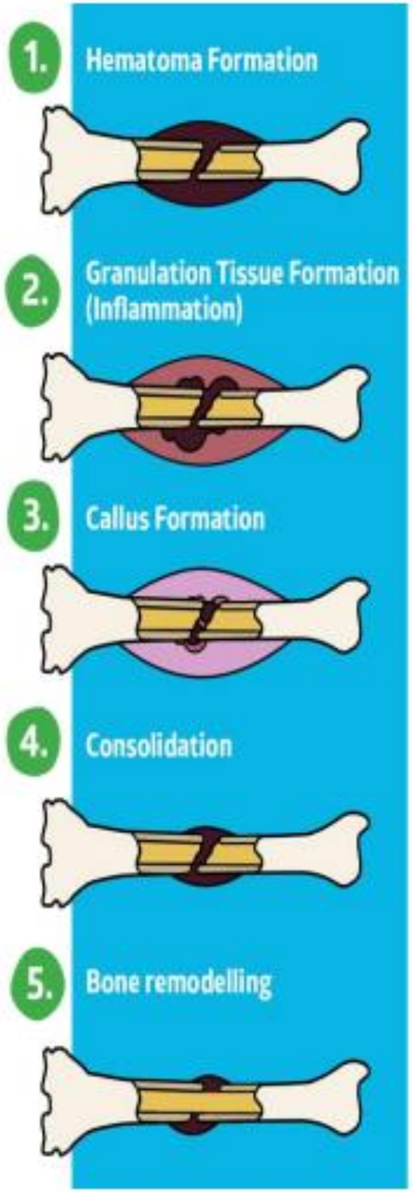

1. Hematoma Formation
2. Granulation Tissue Formation (Inflammation)
3. Callus Formation
4. Consolidation
5. Bone remodelling

Specific fractures

1. Stress fractures: Or Fatigue fracture: abnormal muscular stress applied to normal bone (e.g., march fracture) Insufficiency fracture: normal muscular stress applied to abnormal bone (e.g., osteoporotic vertebral fracture)

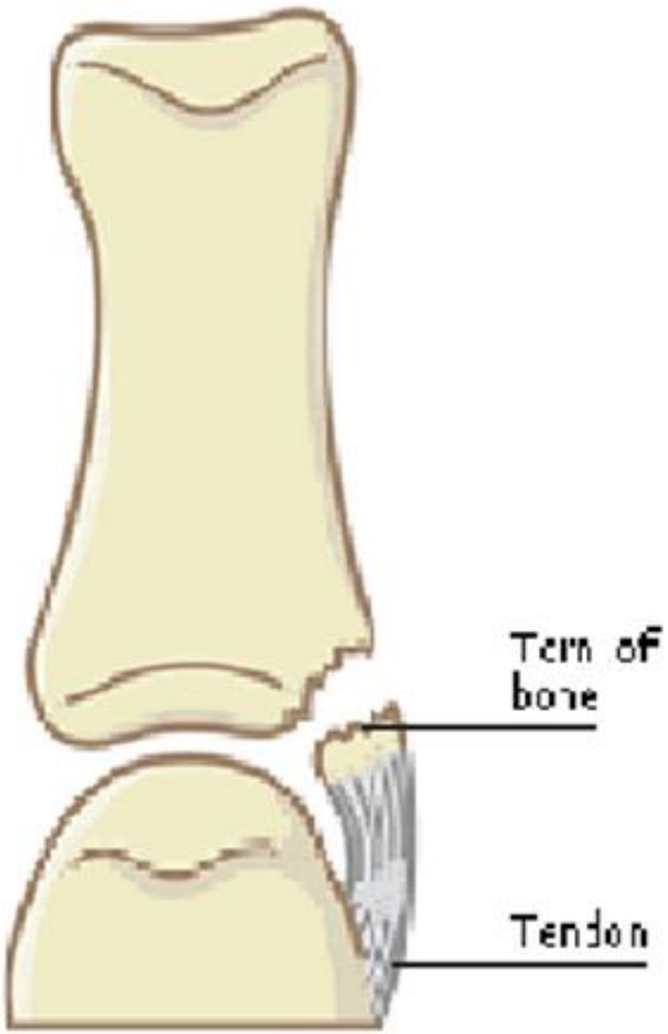
2. Pathological fracture: fracture superimposed on underlying bone disease (e.g. fracture in primary bone tumour or metastasis)

3. Intraarticular fracture: fracture line extends into the joint

4. Avulsion fracture: fragment pulled away from bone at tendinous and ligament insertion (commonly at the tuberosity)

5. Occult fracture: suspected but nonvisualized fracture on plain radiograph; demonstrated by 99mtechnetium (Tc) methylene diphosphonate (MDP) scintigraphy or magnetic resonance imaging (MRI)

6. Salter-Harris fracture: fractures involving the growth plate


Tern of
bone
Tendon


Classification of Salter-Harris fracture

Type I : slipped, fracture plane passes all the way through the growth plate, not involving bone, good prognosis

Type II : above,~75% (by far the most common) , fracture passes across most of the growth plate and up through the metaphysis, good prognosis

Type III : lower, fracture plane passes some distance along with the growth plate and down through the epiphysis, poorer prognosis as the proliferative and reserve zones are interrupted

Type IV : through or transverse or together, intra-articular fracture plane passes directly through the metaphysis, growth plate and down through the epiphysis, poor prognosis as the proliferative and reserve zones are interrupted

Type V : ruined or rammed or crushed, uncommon <1%, crushing type injury does not displace the growth plate but damages it by direct compression, worst prognosis

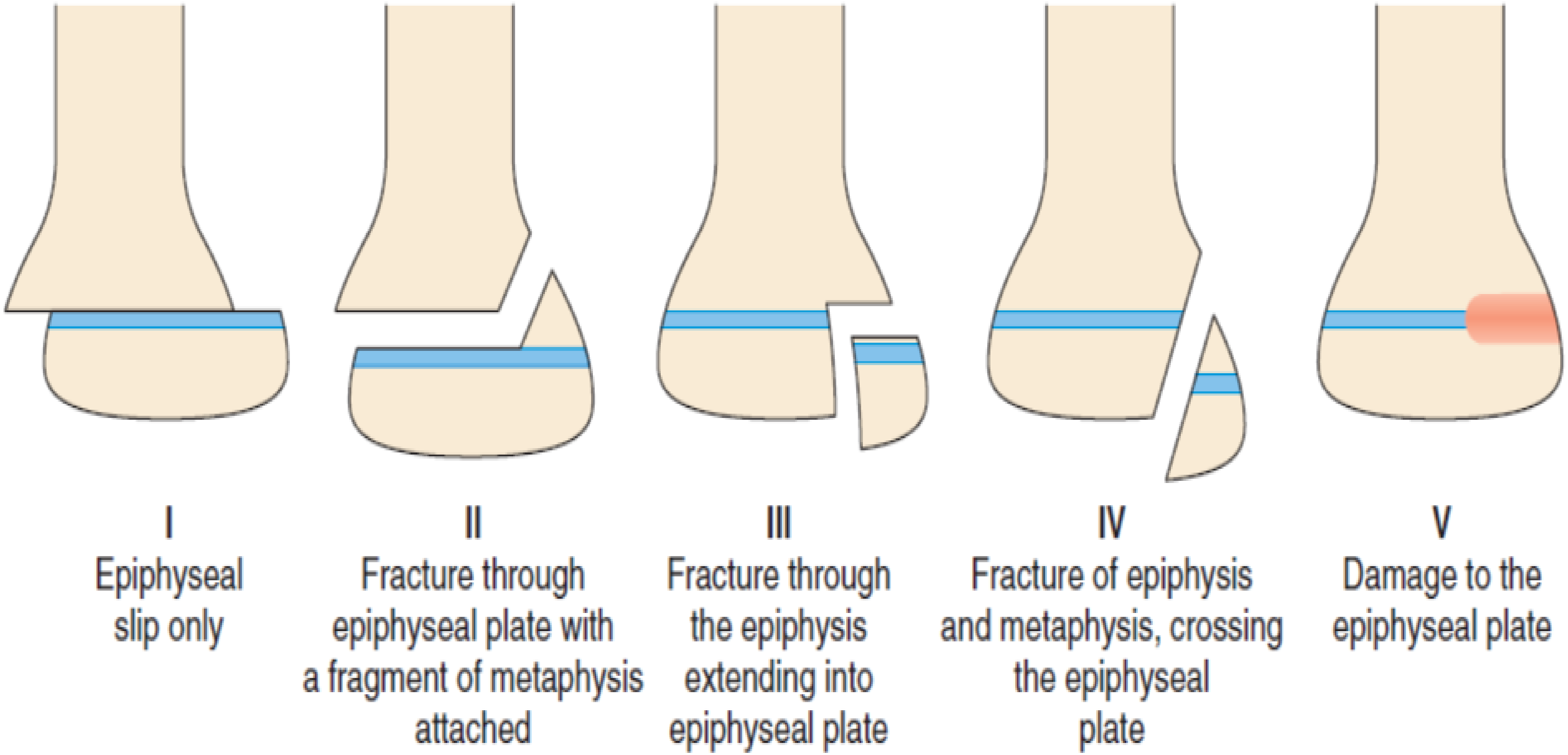


Fig. 27.23 The Salter–Harris classification of fractures.

FRACTURE COMPLICATIONS

Immediate :

1. Haemorrhage, shock
2. Fat embolism
3. Acute ischemia
4. Spinal cord injury, epidural hematoma

Delayed Complication

1. Nonunion: Is a complete arrest of the process of union. If the causes of delayed union are not recognised and treated, the fracture may result in nonunion. Causes

- Loss of bone following an open fracture
- Muscle interposition between the fracture ends, or retraction of fractured ends due to the pull of muscles, such as patellar or olecranon fractures, may result in nonunion.
- Infection after an open fracture may result in an infected nonunion.

Treatment of nonunion should ensure good contact of the fracture ends with proper stabilisation and bone grafting.

2.Delayed union :

Some fractures may not unite within the expected time frame and clinically there is tenderness at the fracture site.

Delayed union may be due to incorrect splintage , or infection following open fractures, and is more common in certain sites, such as the distal femur and tibia .

3.Malunion : Fracture ends may unite in a malposition, resulting in unacceptable angulation, rotation or shortening .

It is important to recognise unsatisfactory reduction of the fracture at the time of surgery or possible loss of reduction during the period of immobilisation.

Unacceptable malunion requires corrective osteotomy.

4.Osteoporosis due to disuse

5.Secondary osteoarthritis

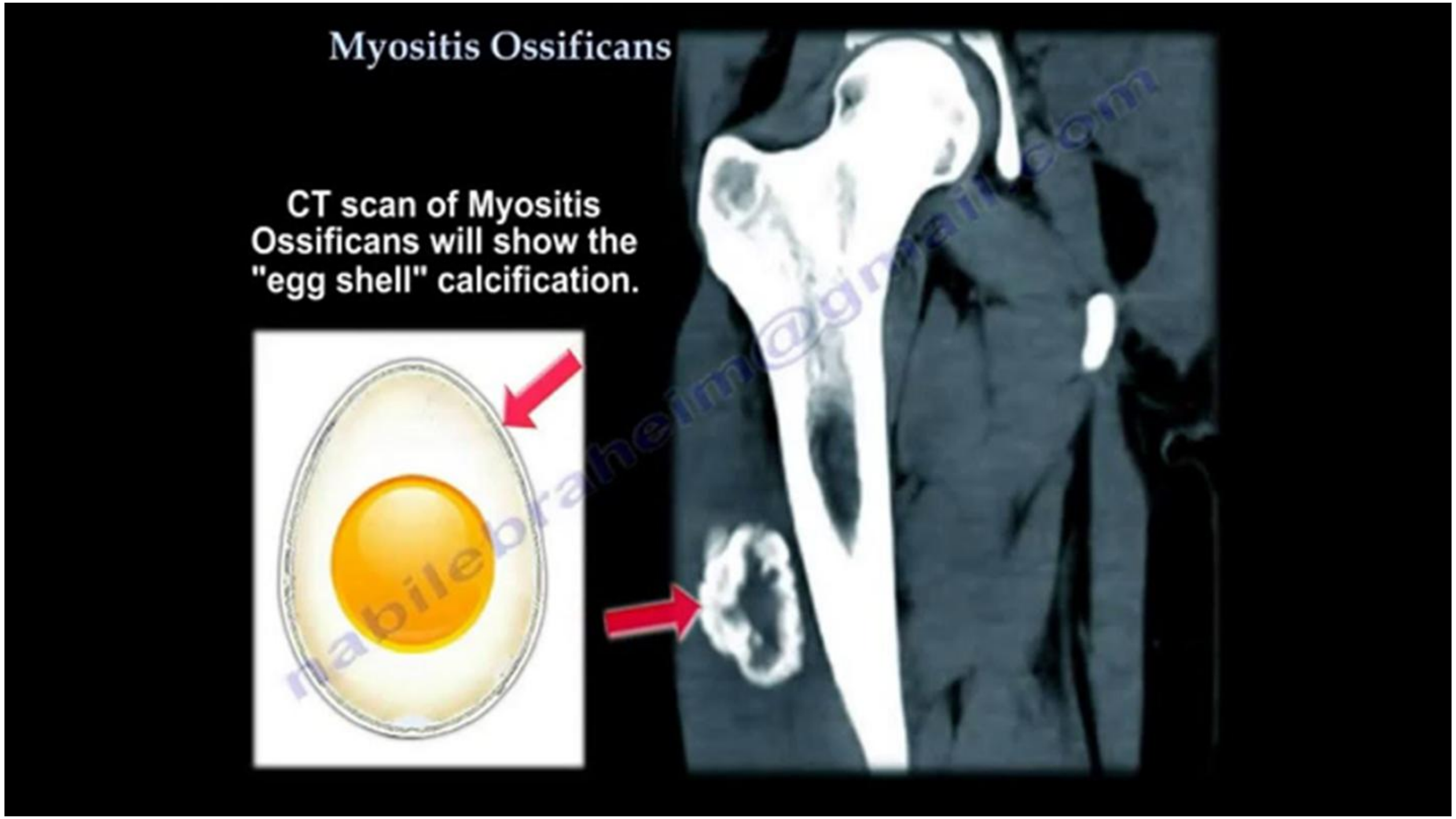
6.Myositis ossificans : is the most common form of heterotopic ossification,

usually within large muscles. Its importance stems in large part from its ability

to mimic more aggressive pathological processes.

7. Osteomyelitis

8.Osteonecrosis


Myositis Ossificans
CT scan of Myositis Ossificans will show the "egg shell" calcification.

Radiographic features

Fractures are generally imaged using plain radiographs; however, there are a number of situations in which CT, MRI or bone scans are useful.

When 3D anatomy is complex (e.g. joints, wrists, feet, the base of skull, spine), plain films are insensitive to non-displaced fractures (e.g. base of skull, spine, sacrum, or proximal neck of femur) and when a pathological fracture is suspected.

Both plain radiographs and CT rely on the identification of discontinuity of bone at the fracture site.

In contrast, MRI relies primarily on visualising soft tissue and bone marrow changes, whereas nuclear medicine (e.g. bone scans) visualises bone metabolic changes.

Plain radiograph

The radiographic positions should be optimal for the evaluation on plain radiograph to be valid. **Radiographic features include :**

- Discontinuity of the cortical and trabecular bon
- Step off in cortical and trabecular bone
- Displacement of osseous fragments
- Presence of abnormal fat pad or elevation of fat pad and Impaction lines or sclerotic bands

CT

CT is useful in detecting occult fractures. Several advantages of CT includes:

Short acquisition time,

Ability to acquire volumetric image of the bone, with good spatial resolution.

CT is also useful in excluding bone marrow edema, space-occupying lesions such as malignancy, and osteomyelitis.

Some features of fractures include : discontinuity of the cortical and trabecular bone , depressed/depressed articular surfaces , increased medullary density , endosteal sclerosis , sclerotic lines in trabecular bone and periosteal thickening

MRI

It is useful in detecting bone oedema in stress fractures and emphasize soft tissue masses , it is used in detecting bone fractures associated injuries likes ligament and meniscal tear , complications like osteomyelitis and avascular necrosis .

Treatment and prognosis

- The fundamentals of fracture healing rely on alignment and immobilization.
- Alignment may or may not be necessary depending on the degree of displacement, the importance of correct alignment (e.g. index finger vs rib) and the particulars of the patient (e.g. professional athlete vs debilitated elderly).
- Immobilization can be achieved in a variety of ways depending on the location and morphology of the fracture.

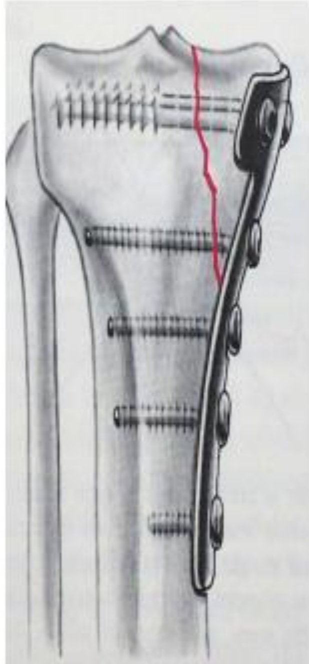
Types of treatment

1.none (e.g. most rib fractures)
2.sling (e.g. many clavicular fractures)
3.cast (e.g. many forearm fractures)
4.internal fixation (e.g. most hip fractures): open vs closed reduction
5.external fixation

Hold

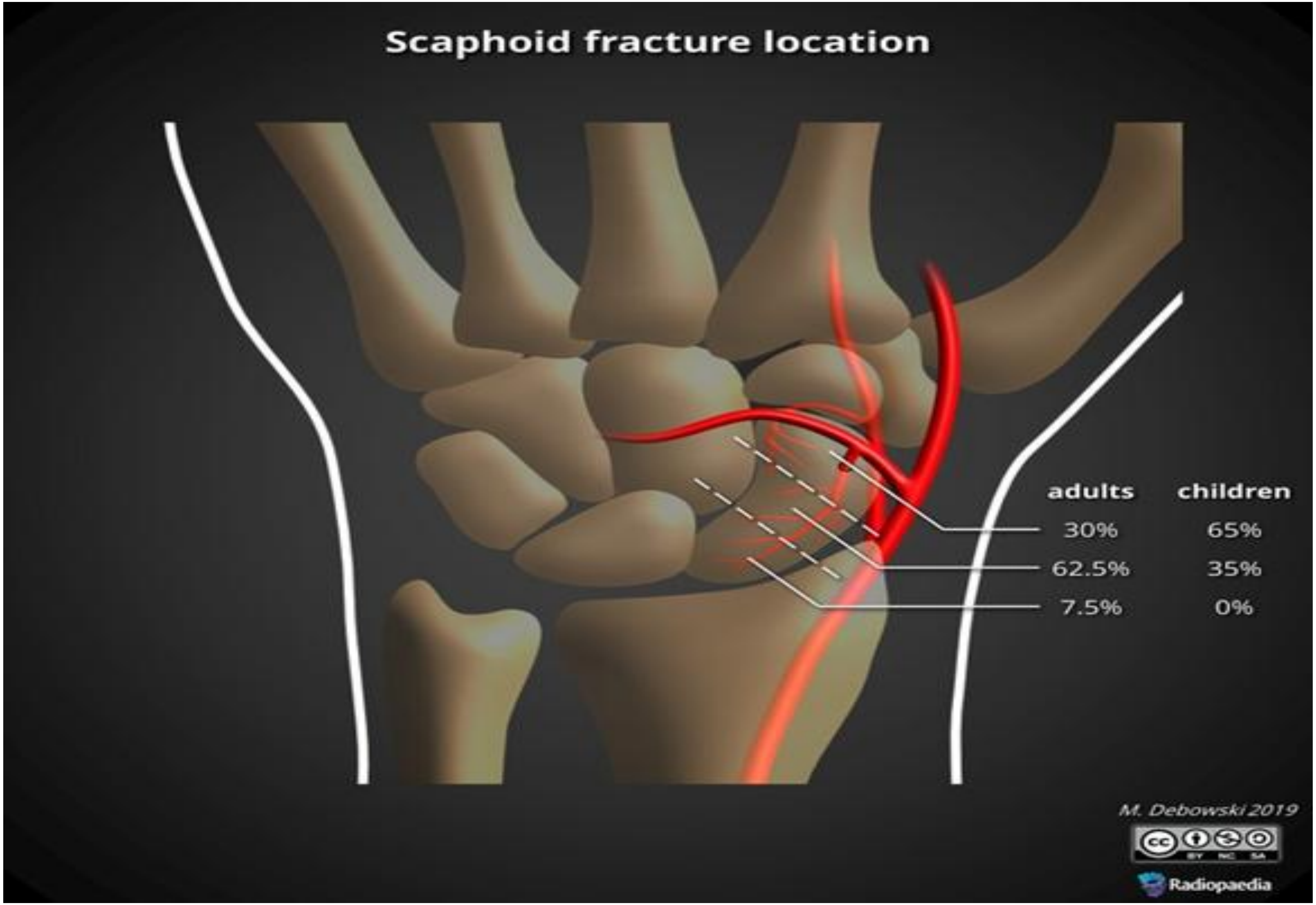
The available methods of holding reduction are:

- Continuous traction.
- Cast splintage.
- Functional bracing.
- Internal fixation.
- External fixation.



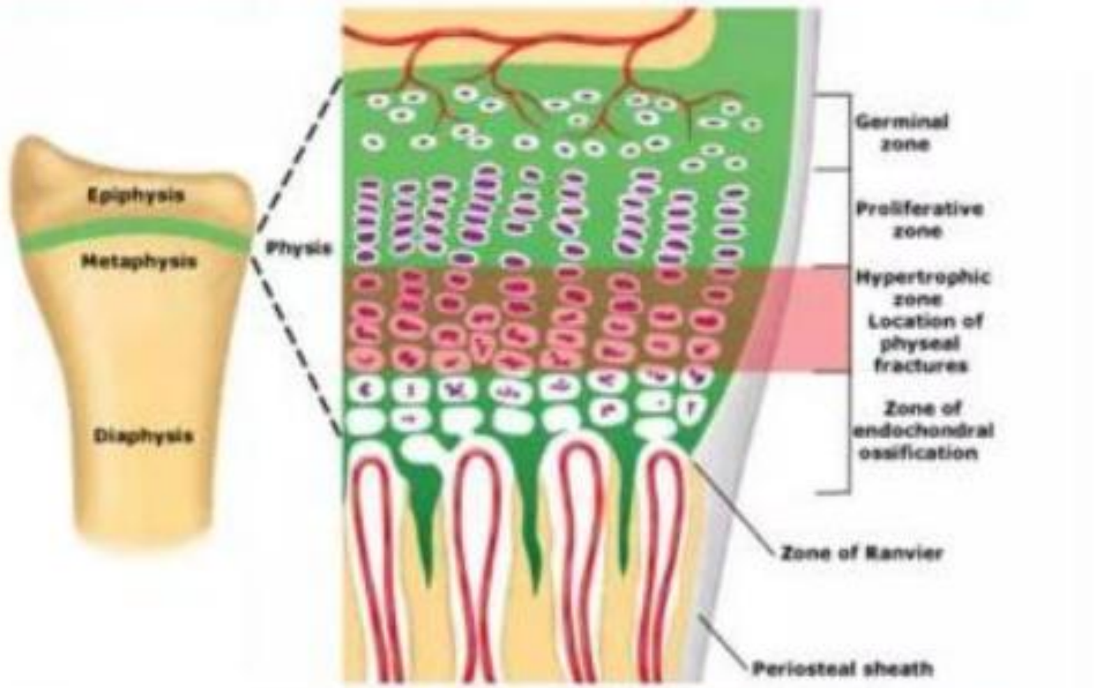
Scaphoid fractures

- These may present with subtle symptoms and signs: typically, pain and tenderness in the anatomical snuffbox following a fall on the outstretched hand.
- Initial x-rays may fail to demonstrate the fracture and, if clinical suspicion is high, it is wise to immobilize the wrist and repeat the x-ray with posteroanterior, oblique, lateral and angled posteroanterior (ulnar deviation) views at 2 weeks.
- If suspicion is still high but the x-rays appear normal, further imaging (MRI) should be performed.
- The scaphoid gains its blood supply for the proximal portion through blood vessels that pass from the distal to proximal pole. Thus, a displaced fracture in the proximal portion of the scaphoid may disrupt the blood supply and lead to nonunion or avascular necrosis, leading to secondary arthritic change.


Scaphoid fracture location
adults
children
30%
65%
62.5%
35%
7.5%
0%
M. Debowski 2019
Radiopaedia

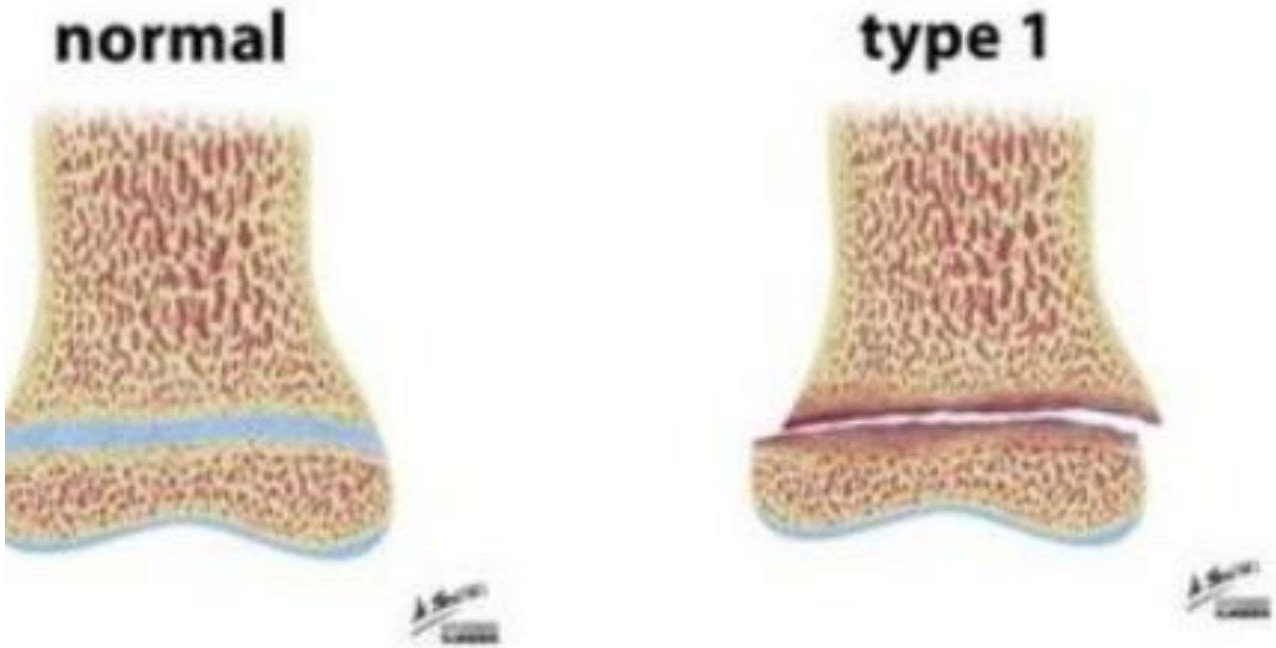
physeal plate

Anatomy of the growth plate (physis)



The germinal zone of the physis borders the epiphysis. The epiphyseal cartilage cells grow toward the metaphysis and form columns of cells. These columns degenerate, undergo hypertrophy, and then calcify at the metaphysis to form new bone. The hypertrophic zone (shaded red) is the usual site of physeal fractures.

Salter-Harris fractures (physeal plate injuries)



Salter-Harris fractures (physeal plate injuries)

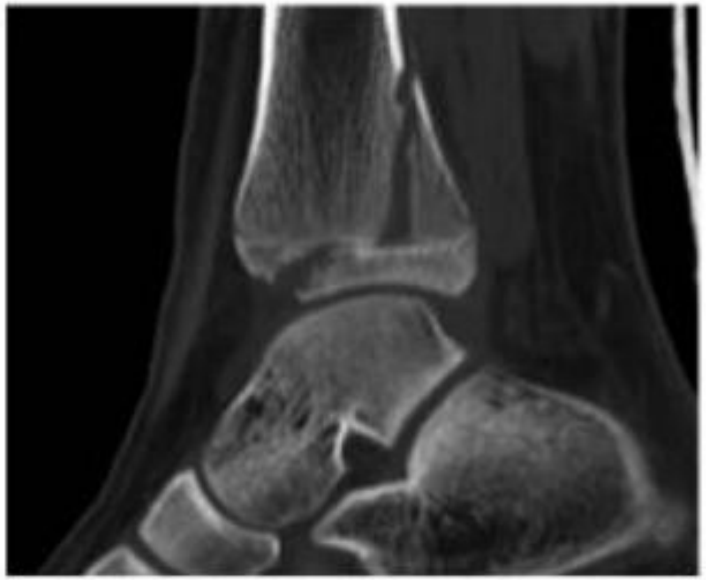
type 2

Salter-Harris fractures (physeal plate injuries)

type 3

Salter-Harris fractures (physeal plate injuries)

type 4



Salter-Harris fractures (physeal plate injuries)

type 5