Principles of Pediatric Fractures

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Introduction

Fractures account for ~15% of all injuries in children.

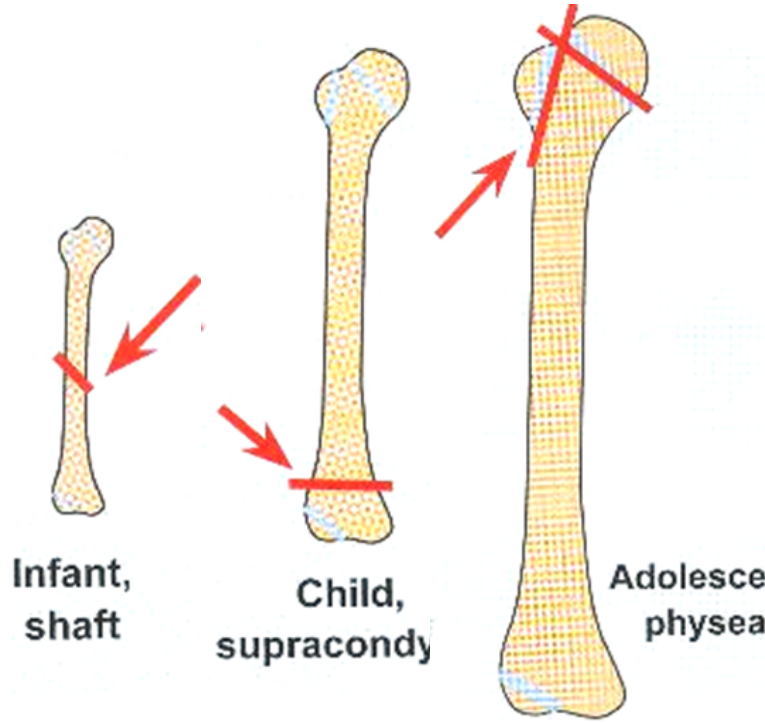
Different from adult fractures

Vary in various age groups

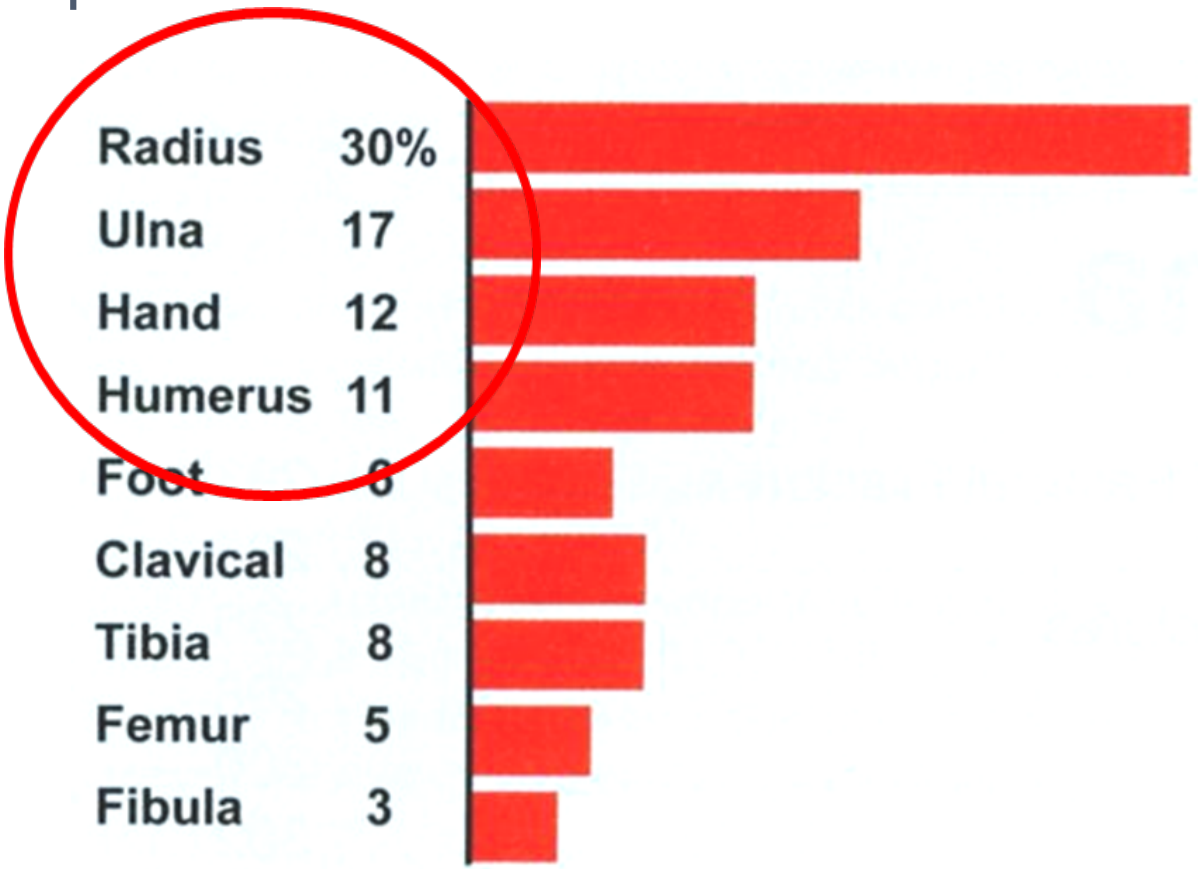
(Infants, children, adolescents)

Age related fracture pattern:

- Infants: diaphyseal fractures
- Children: metaphyseal fractures
- Adolescents: epiphyseal injuries



- Most frequent sites

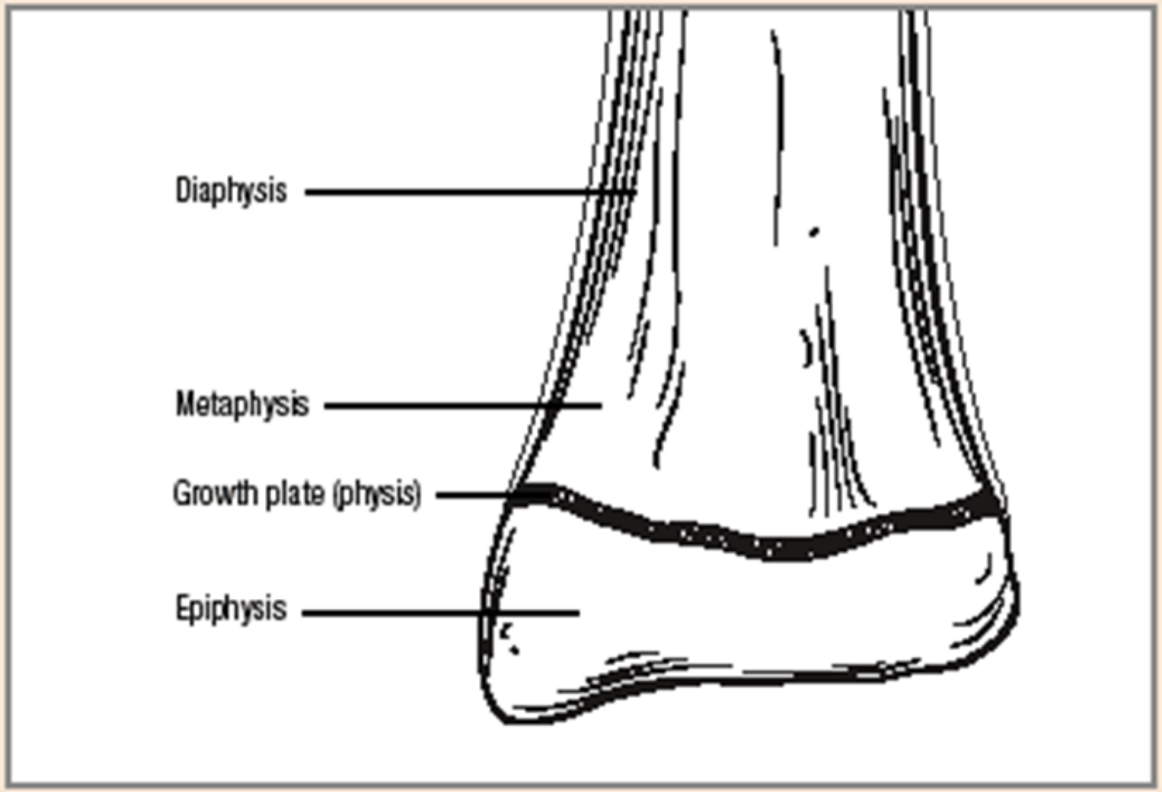


ANATOMY OF GROWING BONE

1. Epiphysis
2. Physis (growth plate)
3. Metaphysis
4. Diaphysis
5. Periosteum

FIGURE 1

The anatomic regions of growing bone



Why are children's fractures different?

Children have different physiology and anatomy

Growth plate: is a hyaline cartilage plate in the metaphysis at each end of a long bone. The plate is found in children and adolescents; in adults, who have stopped growing, the plate is replaced by an **epiphyseal line**.

In infants, GP is stronger than bone ?

1. **increased diaphyseal fractures.**
2. **Provides perfect remodeling power.**
3. **Injury of growth plate causes deformity.**
4. **A fracture might lead to overgrowth.**

cartilage :

increased ratio of cartilage to bone :
-Better resilience
-difficult x-ray evaluation
-size of articular fragments often under-estimated.

Periosteum :

-Metabolically active: more callus, rapid union, increased remodeling, rapid healing
-Thicker and strengthy Intact periosteal affects fracture pattern
-May aid reduction
-Displacement is more controlled

Why are children's fractures different?

Fractures in growing bones are subject to influences which do not apply to adult bones:

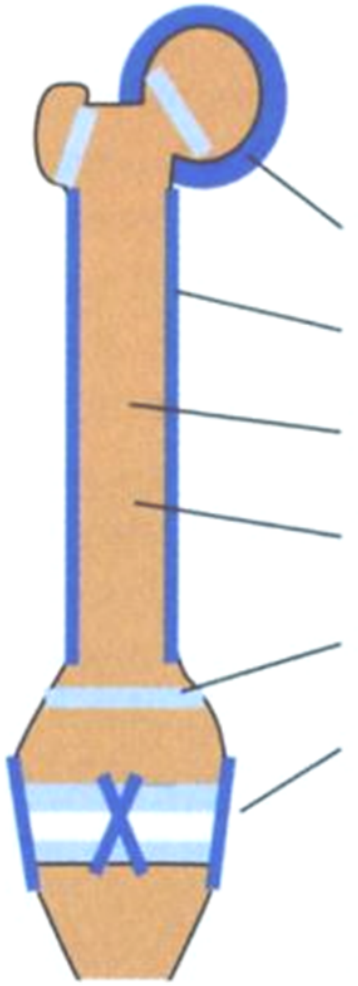
- In very young children the bone ends are largely cartilaginous and therefore do not show up in x-ray images. Fractures at these sites are therefore difficult to diagnose:
  always x-ray both limbs (for comparison) and an ultrasound scan may be helpful.
- Children's bones are less brittle, and more liable to plastic deformation, than those of adults; Hence the frequency of incomplete fractures ,torus fractures and greenstick fractures, injuries which are very rare in adults.
- In childhood the periosteum is thicker than in adult bones; this may explain why fracture displacement is more controlled .

Why are children's fractures different?

- Increased cancellous bone
- Which reduces tendency of fracture to propagate so less comminuted fractures incidence in children than in adult

- Cellular activity is also more marked, which is why children's fractures heal so much more rapidly than those of adults. The younger the child, the quicker the rate of union. Non-union is very unusual in children's fractures.
- Bone growth involves considerable modelling and re-modelling, processes which determine the structure and overall form of the bone. This makes for a great capacity to re-shape fracture deformities over time.
- Damage to the growth plate can have serious consequences however rapidly and securely the fracture might heal.

Children's bones are different



Feature	Management effect
Thick joint cartilage	Not imaged by x-ray
Thick periosteum	Healing rapid
More collagen	Fractures easily
More cancellous bone	Simple fracture patterns
Growth plate	Remodels deformity
Ligaments stronger	Bone fails first

IT'S GOOD TO BE YOUNG

- Children tend to heal fractures faster than adults
- Advantage: shorter immobilization times
- Disadvantage: misaligned fragments become "solid" sooner

- Mild angulation deformities often correct themselves
- Rotational deformities require reduction

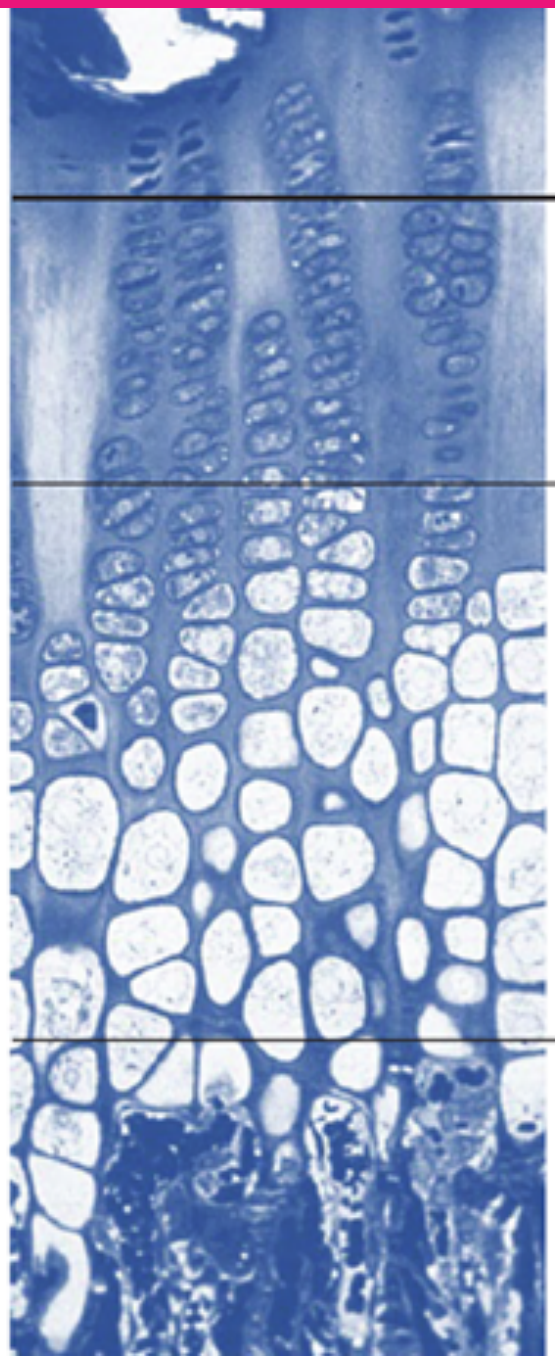
- Fractures in children may stimulate longitudinal bone growth
- Some degree of bone overlap is acceptable and may even be helpful

- After casting, callus is formed but still may be fibrous
- Avoid contact activities for 2-4 weeks once out of cast

Injuries of the physis

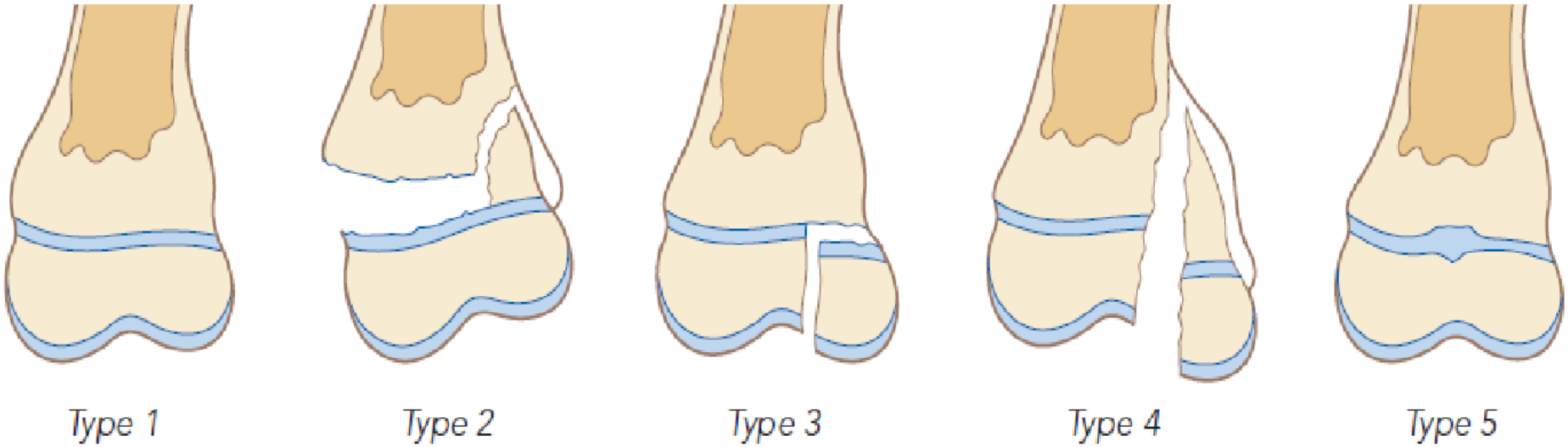
- Over 10% of childhood fractures involve injury to the growth plate (or physis).
- Because this is a relatively weak part of the bone, injuries that cause ligament strains in adults are liable to disrupt the physis in children.
- The fracture usually runs transversely through the hypertrophic (calcified) layer of the growth plate
- This has little effect on longitudinal growth
- However, if the fracture traverses the cellular 'reproductive' layers of the plate, it may result in premature ossification of the injured part and cessation of growth or deformity of the bone end.

- Classification system to delineate risk of growth disturbance
  - **Higher grade fractures are more likely to cause growth disturbance**
  - **Growth disturbance can happen with ANY physeal injury**

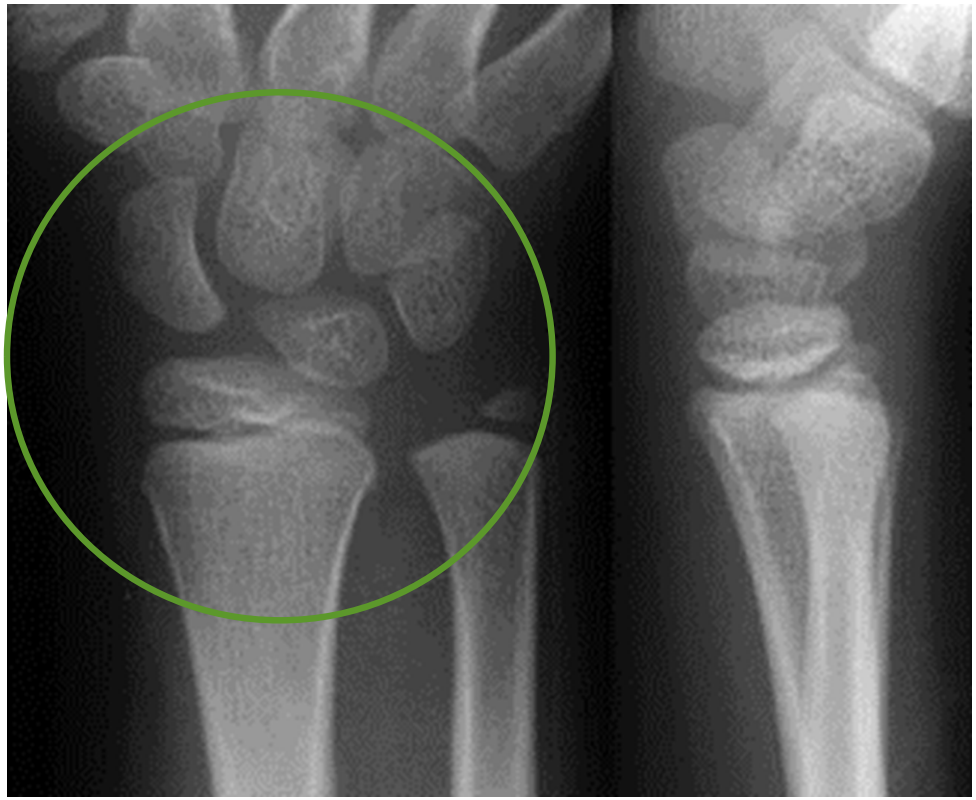

Epiphysis
Reserve zone
Zone of proliferation
Zone of hypertrophy
Metaphysis
Zone of provisional ossification

Classification: Salter and Harris

- Type 1: a transverse fracture through the hypertrophic or calcified zone of the plate. the growing zone of the physis is usually not injured and growth disturbance is uncommon.
- Type 2: this is similar to Type 1, but towards the edge the fracture deviates away from the physis and **splits off a triangular piece of metaphyseal bone.** Growth is usually not affected.
- Type 3: this fracture runs partly along the physis and then veers off through all layers of the physis and the epiphysis into the joint. Inevitably the reproductive zone of the physis is damaged and this may result in growth disturbance.
- Type 4 this fracture splits the epiphysis, but it continues through the physis into the metaphysis. The fracture is particularly Liable to displacement and a consequent misfit between the separated parts of the physis, resulting in asymmetrical growth.
- Type 5: a longitudinal compression injury of the physis. There is no visible fracture but the **growth plate is crushed and this may result in growth arrest.**



23.7 Physeal injuries *Type 1* – separation of the epiphysis. *Type 2* – fracture through the physis and metaphysis (the commonest type). *Type 3* – here the fracture runs along the physis and then veers off into the joint, splitting the epiphysis. *Type 4* – vertical fracture through the epiphysis and the adjacent metaphysis. *Type 5* – crushing of the physis without visible fracture.



Type 1

Type2

type3

AP

Lateral

type4

type5

Injuries of the physis

- **MOST COMMON: Salter Harris _II_** . Followed by I, III, IV, V

- Don't forget to tell the parents that growth disturbance can happen with any physeal fracture.
- Clinical features Physeal fractures usually result from falls or traction injuries; they occur mostly in road accidents and during sport or playground activities and are more common in boys than in girls. Deformity is usually minimal, but any injury in a child followed by **pain and tenderness near the joint** should arouse suspicion, and x-ray examination is essential.
- X-rays
- The physis itself is radiolucent and the epiphysis may be incompletely ossified; this makes it hard to tell whether the bone end is damaged or deformed.
  The younger the child, the more difficult it is to make the diagnosis
  comparison with the normal side is a great help.
  Telltale features are widening of the physeal 'gap', incongruity of the joint or tilting of the epiphyseal axis. If there is marked displacement the diagnosis is obvious, a second x-ray examination after 4 or 5 days is essential.
  Type 5 injuries are usually diagnosed only in retrospect.

- **Features of physeal fractures:**

1) widening of the physeal gap.
2) incongruity of the joint.
3) tilting of the epiphyseal axis.
4) marked displacement.

Treatment

- Undisplaced fractures:

Splinting in a cast or a close-fitting plaster slab for 2-4 weeks (depending on the site and age).

- But with types 3 & 4, a check x-ray after 4 days and again at 10 days is mandatory in order not to miss a late displacement.

Displaced fractures:

- Types 1 & 2 ? closed reduction and then splinting for 3-6 weeks.
- Types 3 & 4 ? try closed reduction, if successful apply a splint for 4-8 weeks
- if unsuccessful? do open reduction and internal fixation.

Complications

- Premature fusion

Type 1 and 2 injuries, if properly reduced, usually have an excellent prognosis and bone growth is not adversely affected.

- **Exceptions to this rule are: injuries involving the distal femoral and proximal tibial physes**

- Type 3, 4 and 5 injuries are more likely to cause premature fusion of part of the growth plate, resulting in cessation of growth or **asymmetrical growth** and deformity of the bone end.

The size and position of the bony bridge across the physis can be assessed by CT or MRI. If it is relatively small it can be excised and replaced by a fat graft, However, if the bone bridge is more extensive the remaining part of the physis is closed surgically; the resulting deformity or length discrepancy will have to be dealt with later by osteotomy

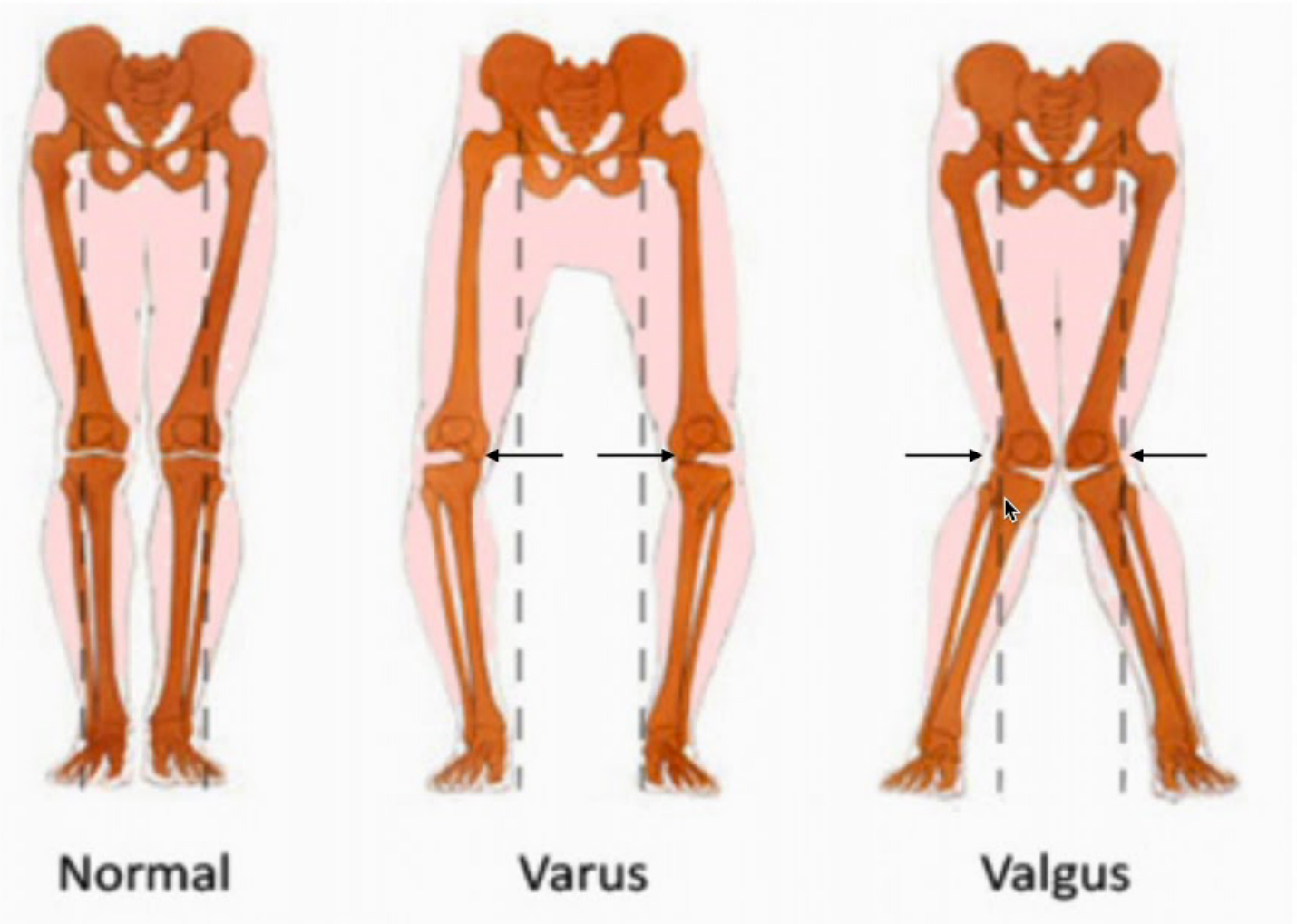
Complications

- Deformity

Established deformity, whether from asymmetrical growth or from mal-union of a displaced fracture

(e.g. a valgus elbow due to proximal displacement or non-union of a lateral humeral condylar

fracture) should be treated by corrective osteotomy.


Normal
Varus
Valgus

INJURY PATTERN IN GROWING BONES

- **Bones tend to BOW rather than BREAK**

- Compressive force → TORUS fracture ,. Buckle fracture.
- Force to side of bone → may cause break in only one cortex → GREENSTICK fracture
  The other cortex only BENDS
- In very young children, neither cortex may break → PLASTIC DEFORMATION

- **Point at which metaphysis connects to physis is an anatomic point of weakness**
- Periosteum is biologically active in children and often stays intact with injury, This stabilizes fracture and promotes healing

Classification of pediatric fractures

- Pediatric fractures can be classified as complete and incomplete:

- Incomplete:
  there are three basic forms of incomplete fractures:
- The greenstick fracture: a transverse fracture of the cortex which extends into the midportion of the without disrupting the opposite cortex.
- The torus or buckling fracture, caused by impaction. They are usually the result of a force acting on **the longitudinal axis of the bone like** a fall on an outstretched arm, they mainly involve the **distal radial** metaphysis..
- The bow fracture in which the bone becomes curved along its longitudinal axis.
- Complete fractures

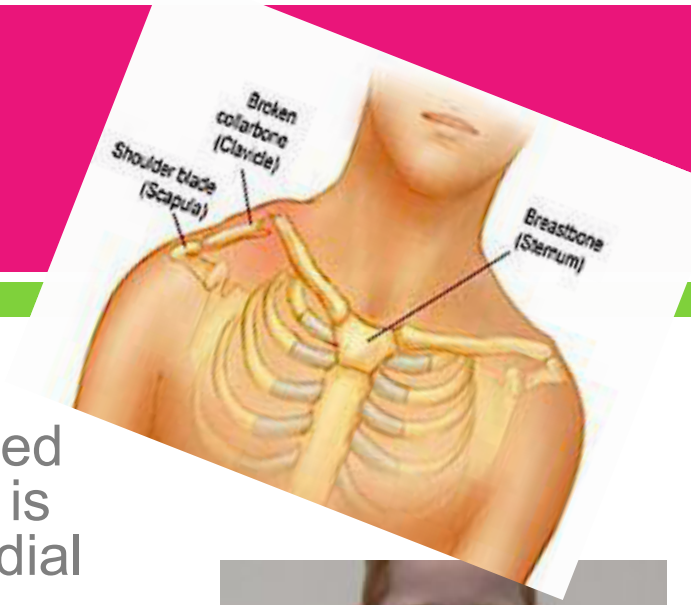
A buckle fracture of the distal

bow

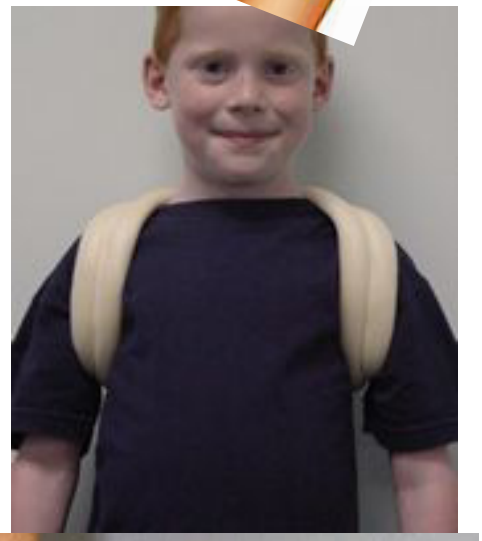
Greenstick fractures on X-

COMMON FRACTURES

CLAVICLE



- Most occur in the middle third of the bone
- Mechanism: A fall on the shoulder or the outstretched hand may fracture the clavicle; the lateral fragment is pulled down by the weight of the arm, while the medial fragment is held up by the sternomastoid muscle.
- Clinical: pain with any shoulder movement The fracture is almost always displaced, producing a lump ,Point tender over fracture, subQ crepitus. Often obvious deformity. in children the bone is soon re-modelled.
- Diagnosis :X- ray with AP view often sufficient to diagnose .Consider **45o cephalic tilt** view if needed.
- Treatment: For the usual middle-third fracture support the arm in **figure-of-eight bandage sling until the pain subsides** (usually 1–3 weeks).
- outer-third fractures may need open reduction and internal fixation.



Fractures of the distal humerus in children

- The elbow is second - only to the distal forearm - for frequency of fractures in children.
- Most of these injuries are **supracondylar fractures**
- Boys are injured more often than girls and more than one half of the patients are under 10 years old.
- **Mechanism :** The usual accident is a fall directly on the point of the elbow or onto the outstretched hand with the elbow forced into valgus or varus.
- **Clinical :**Pain and swelling are often marked. In X-ray the bone ends are largely cartilaginous and therefore radiographically incompletely visualized.

Anatomy of the elbow

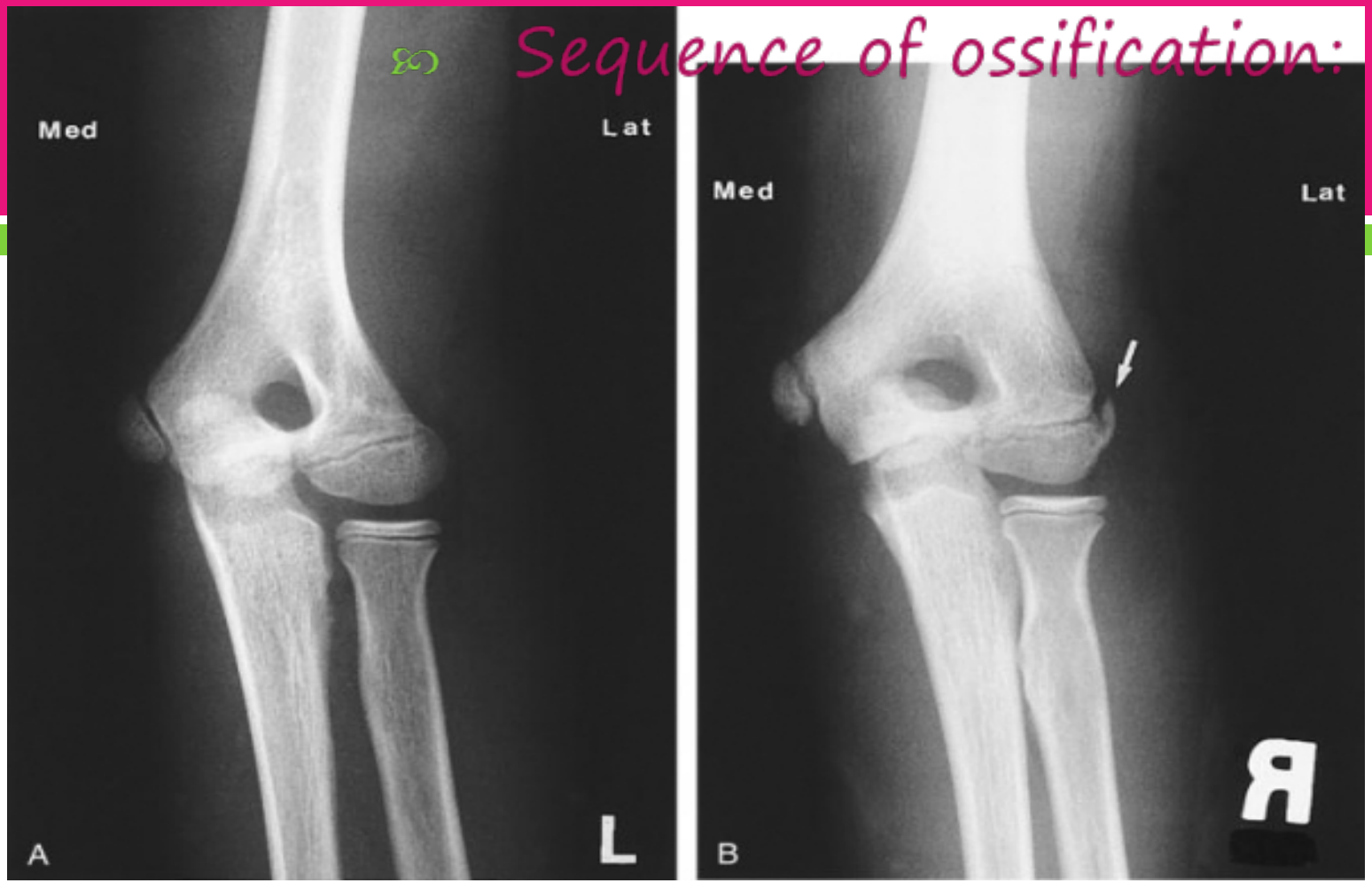
- A good knowledge of the normal anatomy is essential if fracture displacements are to be recognized
- The elbow is a complex hinge. Its stability can be compromised by any break in the articulating structures.
- The surrounding soft-tissue structures also are important, especially the capsular and collateral ligaments.

- With the elbow extended, the forearm is normally in slight valgus in relation to the upper arm, the average carrying angle in children being about 15 degrees.

- When the elbow is flexed, the forearm comes to lie directly upon the upper
- arm.

- **Malunion of a supracondylar fracture will inevitably disturb this relationship.**

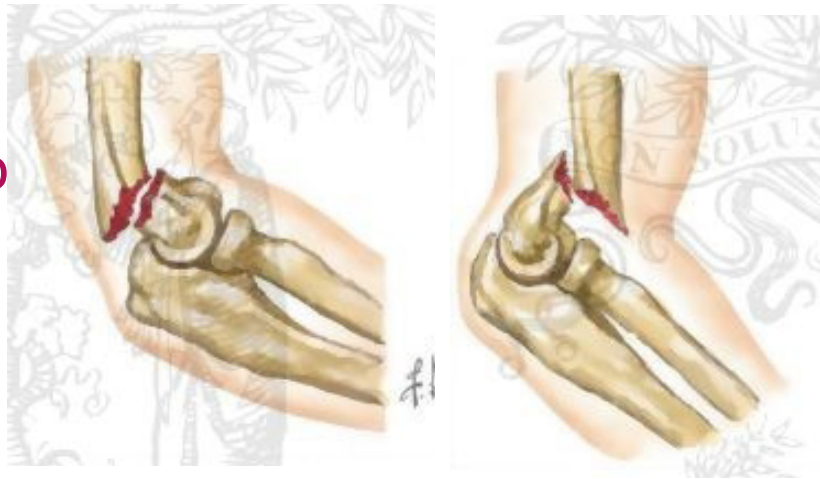
Sequence of ossification:



Come Read My Tale Of Love
Capitellum, Radial head, Medial epicondyle, Trochlea, Olecranon, Lateral epidondyle
Age 1, 3, 5, 7, 9, 11

Supracondylar fractures

- Common fracture in children.
- The distal fragment may be displaced either posteriorly or anteriorly, medially o laterally; sometimes it is also rotated.



- Posterior displacement and tilt is the commonest (95% of all cases),
  ** suggesting a hyperextension injury, usually due to a fall on the outstretched hand.
  May injure the brachial artery or median nerve.
- Anterior displacement is rare, but may result from **over-reduction of the usual posterior displacements.**

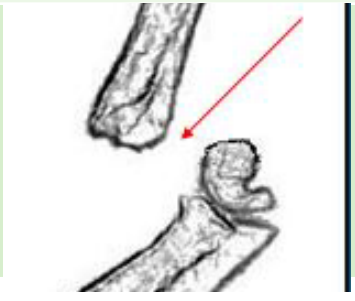
Supracondylar fractures

- **Special features** :Following a fall, the child is in pain and the elbow is swollen
- with a posteriorly displaced fracture, the S-deformity of the elbow is usually obvious.
  It is essential to feel the pulse and check the capillary return.

- **pain plus one positive sign demands urgent action.**

1. pain on passive extension of the fingers
2. tense and tender forearm
3. an absent pulse
4. blunted sensation
5. reduced capillary return on pressing the finger pulp

SUPRACONDYLAR FRACTURE CLASSIFICATION

Type I-	non-displaced or minimally displaced	long arm cast, forearm neutral , elbow 90o for 4 wks • Bivalve cast if acute • Follow-up xrays 3-7 days • Xrays at 4 weeks to document callus • Once callus noted at 4 weeks, discontinue cast	
Type II-	displaced distal fragment with intact posterior cortex		
Type III	displaced with **no contact** between fragments	Type 3 Going to OR. No pulse AND cold hand AND delay in OR then ER attempt at reduction	

Supracondylar fractures

X-rays:

- Undisplaced fractures are easily missed; there may be no more than haematoma.
- In posteriorly displaced fracture the distal fragment is tilted backwards .
- In the rare anteriorly displaced fracture the fragment is tilted forwards.
- The AP x-ray is often difficult to interpret because it is taken with the elbow flexed. The degree of angulation may therefore not be appreciated.
- This is where Baumann's angle is most helpful

Treatment:

- If there is even a suspicion of a fracture, the elbow is **gently splinted in 30 degrees of flexion** to prevent movement and possible neurovascular injury during the x-ray examination.
- Undisplaced fractures The elbow is immobilized at 90 degrees and neutral rotation in a cast and the arm is supported by a sling for 3 weeks

Supracondylar fractures

- Posteriorly minimally angulated fractures the fracture can be **reduced under G.A**
  Following reduction, the arm is held in a collar , the splint is retained for 3 weeks.
- If the acutely flexed position cannot be maintained without disturbing the circulation, or if the reduction is unstable, the fracture should be fixed with (K-wires)

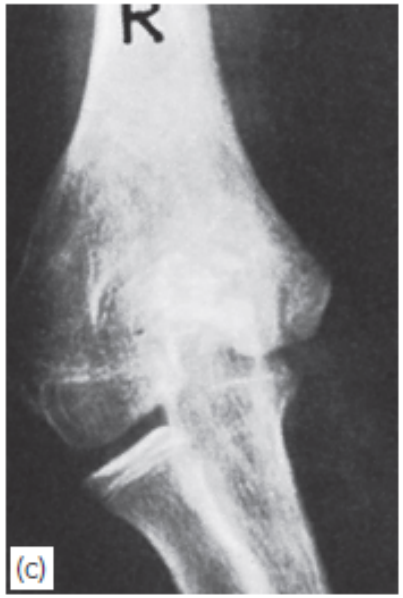
- Posteriorly displaced fractures with severe swelling are often unstable + risk of neurovascular injury or circulatory compromise due to swelling. **The fracture should be reduced under general anaesthesia as soon as possible**, and then held with **K-wires;** this obviates the necessity to hold the elbow **acutely flexed.** Care should be taken not to injure the ulnar and radial nerves.

- Anteriorly displaced fractures Reduction and A posterior slab is bandaged on and retained for 3 weeks.

Supracondylar fractures

Complications

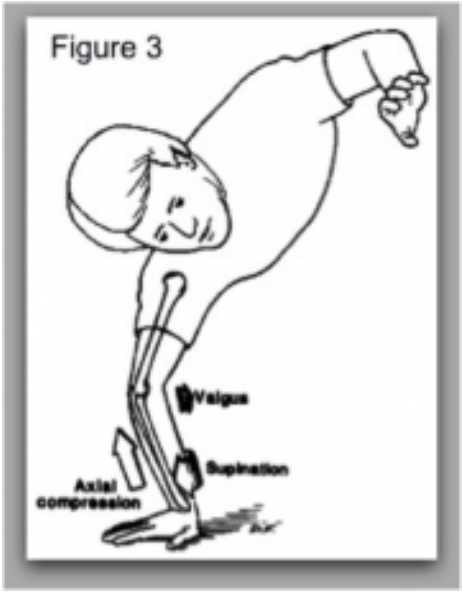
1. **Vascular injury:** The great danger of supracondylar fracture is injury to the **brachial artery**, Peripheral ischaemia may be immediate and severe, or the pulse may fail to return after reduction.
2. **compartment syndrome**
3. Nerve injury: The median nerve may be injured. Fortunately, loss of function is usually temporary and recovery can be expected in 6–8 weeks.
4. Malunion : is common. May be gradually smoothed out by modeling during growth. Forward or backward tilt may limit flexion or extension, but consequent disability is slight.
5. Cubitus varus and cubitus valgus. If deformity is marked, it will need correction by supracondylar osteotomy.
6. Elbow stiffness :Full movement may take months to return. Forced movement will only make matters worse and may contribute to the development of heterotopic ossification

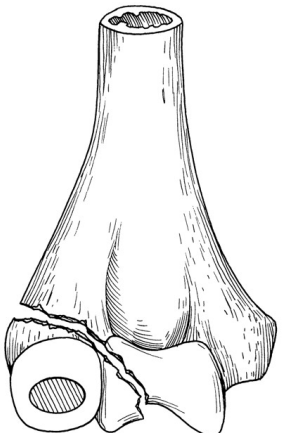


26.16 Supracondylar fractures – complications (a) Varus deformity of the right elbow following incomplete correction of the varus displacement in a supracondylar fracture. (b) The 'gun-stock deformity' becomes more obvious when the arms are raised. (c) X-ray showing the malunion.

Fracture–separation of the lateral condyle

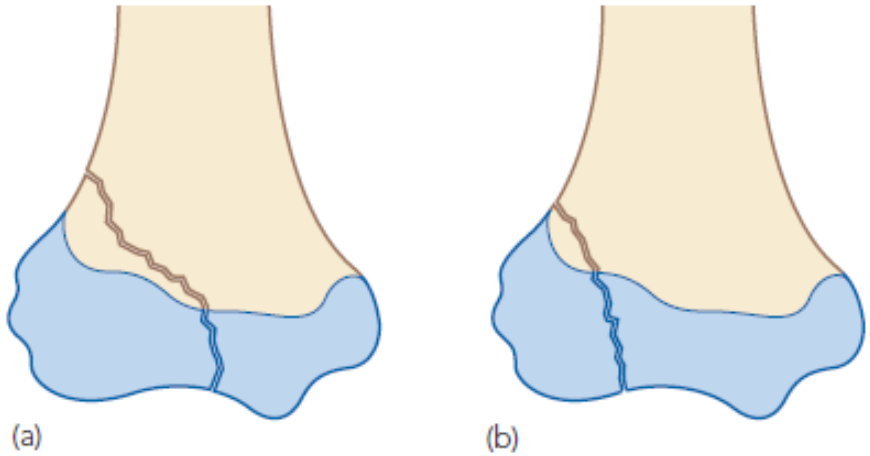
- Second most common elbow fracture
- The distal humeral epiphysis begins to ossify at the age of about 2 years and fuses with the shaft at about 16 years; between these ages, the condylar or epicondylar parts of the epiphysis may be avulsed by the sudden pull of the forearm muscles during a fall on the hand.
- Special features: If the child falls with the elbow stressed in varus, a large fragment including the lateral condyle can be avulsed by the attached wrist extensors.
- The extent of the injury is often not appreciated because the capitellar epiphysis is largely cartilaginous and not visible on x-ray
- Exam: focal swelling at lateral distal humerus





Fracture–separation of the lateral condyle

- Most common x-ray findings:
  - Fracture line begins in distal humeral metaphysis and extends to just medial to capitellar physis into the joint
  - Neurovascular injury rarely



26.17 Physeal fractures of the lateral condyle

Fracture–separation of the lateral condyle

- The elbow joint may be dislocate.
- **The condylar fragment is always larger than the image shown on x-r**
- Treatment
- undisplaced fracture splinting the elbow for 2 weeks and then starting exercises, elbow 90o , At follow-up (weekly), check for late displacement
- displaced fracture reduced by manipulation, but if this fails, operative reduction must be carried out with a K-wires. The wires are moved after 3–4 weeks and the cast can then be discarded.
- **Complications**

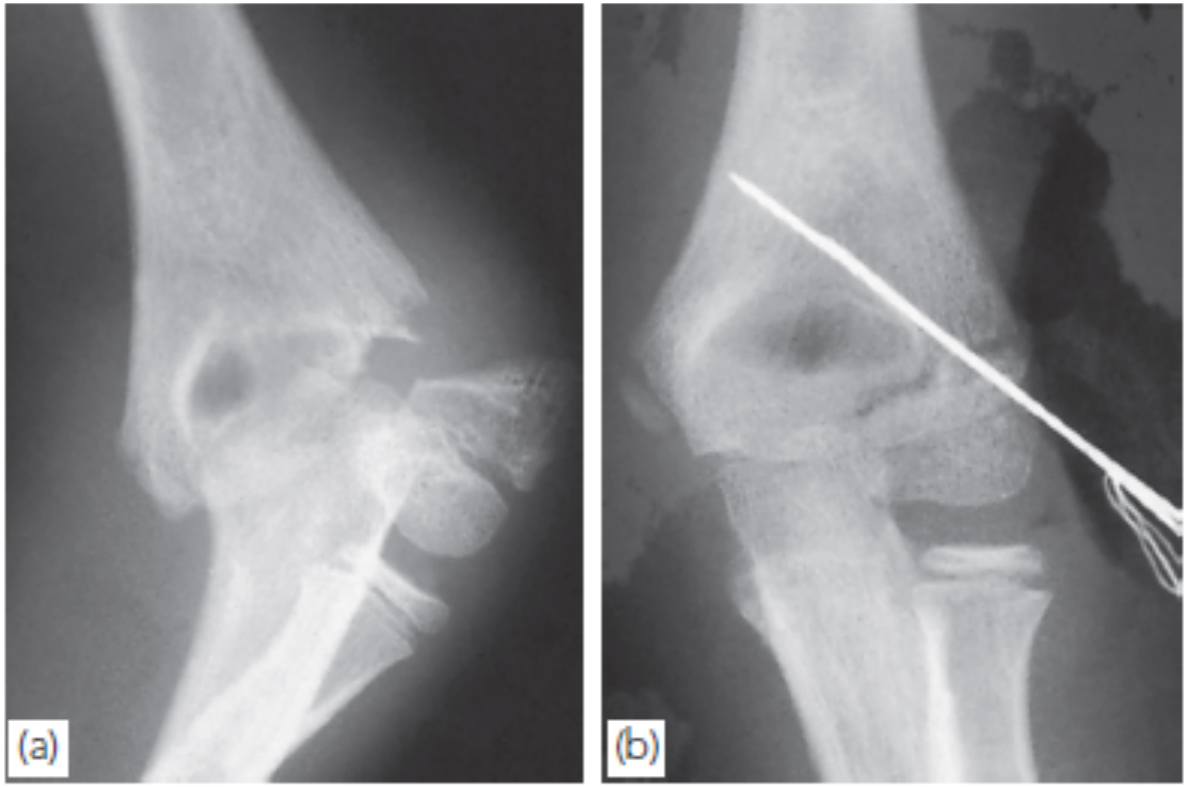
1. **Non-union** and malunion If the condyle is left capsized, **non-union is inevitable** with growth, the elbow becomes increasingly valgus **ulnar nerve** palsy is then likely to develop

2. Recurrent dislocation of the elbow

condylar displacement results in **recurrent posterolateral dislocation** of the elbow. The only effective treatment is reconstruction of the bony and soft tissues on the lateral side.

1. growth arrest

26.19 Fractured lateral co



26.18 Fractured lateral condyle – treatment

Separation of the medial epicondylar apophysis

- **If the wrist is forced into extension**, the medial epicondylar apophysis is avulsed by the attached wrist flexors. The inner side of the elbow is swollen and acutely tender.
- Treatment: the elbow is splinted for 2–3 weeks. However, if the epicondyle is markedly displaced, it should be sutured back in position.

Pulled elbow

- In young children the elbow is sometimes injured by a sharp tug on the wrist.
- The child is in pain; the elbow is held in extension and he or she will not allow it to be moved.
- There are no x-ray changes.
- What has happened is that the *radius* has been pulled distally and the annular ligament has slipped up over the head of the radius.
- A dramatic cure is achieved by **forcefully supinating and then flexing the elbow**; the ligament slips back with a snap.

Fractures of the radius and ulna

- A twisting force cause the bones broken at different levels.
- A direct blow or an angulating force causes transverse fractures of one or both bones at the same level.
- Bleeding and swelling in the muscle compartments of the forearm may cause circulatory impairment.

- Special features: The diagnosis is usually quite obvious, but the

wrist and hand must be carefully examined for **signs of nerve damage or circulatory impairment.**

- X-rays in children they are often incomplete and the bones may appear bent rather than broken.
- Treatment
- In children, closed reduction is usually successful with full-length cast extending from the axilla to the metacarpal shafts (to control rotation). The cast is applied with the elbow at 90 degrees. The position is checked by x-ray after 1 week and, splintage is retained until both fractures are united

DISTAL RADIUS

- **The distal radius is common sites of childhood fractures.** The break may occur through the distal radial physis or in the metaphysis the bones.
- **Metaphyseal fractures are often incomplete or greenstick.**
- The usual injury is a fall on the outstretched hand with the wrist in extension; the distal fragment is usually forced **posteriorly**
- Lesser force may do no more than buckle the metaphyseal cortex (or torus fracture).

DISTAL RADIUS

- Special features :

The wrist is painful, and often quite swollen; sometimes there is an obvious 'dinner-fork deformity'.

- X-rays :

Physeal fractures are almost invariably Salter–Harris Type 1 or 2, with the epiphysis shifted and tilted backwards and radially.

Treatment

- Physeal fractures are reduced, under anaesthesia. The arm is immobilized in a full-length cast with the wrist slightly flexed and ulnar deviated, and the elbow at 90 degrees.
- These fractures **do not interfere with growth**.
- Even if reduction is not absolutely perfect, further growth and modelling will obliterate any deformity within a **year or two.**

OCCULT SALTER HARRIS I

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DISTAL RADIUS PHYSIS FRACTURE

DISTAL RADIUS

- Metaphyseal injuries may appear as buckling of the cortex, as angulated greenstick fractures. If only the radius is fractured, the ulna may be bent though not fractured.

- Treatment
- Buckle (torus) fractures require no more than 2 weeks in plaster\ short cast , followed by another 2 weeks of restricted activity.

Buckle fractures

FIGURE 4

Torus fracture

Anteroposterior (A) and lateral (B) views of the wrist in a young child, showing a subtle torus fracture of the distal radius. Note the radiodense line on the AP view, indicating disruption of the normal trabecular pattern. A slight cortical buckle is seen on the lateral view.

Buckle (torus) fractures

DISTAL RADIUS

Greenstick fractures are usually easy to reduce – but apt to re-displace in the cast!

Some degree of angulation can be accepted.

GREENSTICK FRACTURES

Treatment

If non-displaced

- Short arm cast for 3-6 weeks

If displaced >**15** degrees, reduce and immobilize in long arm for 4 weeks cast

DISTAL RADIUS

Complete fractures :

- can be difficult to reduce – especially if the ulna is intact.
  The fracture is manipulated in much the same way as a Colles' fracture; the reduction is checked by x-ray and a full-length cast is applied with the wrist neutral and the forearm supinated.

DISTAL RADIUS

- Complications
- Forearm swelling and a threatened compartment syndrome are prevented by avoiding over-forceful or repeated manipulations, splitting the plaster, elevating the arm for the first 24–48
- Malunion as a late sequel is uncommon in children under 10 years of age.
- Deformity of as much **as 30 degrees** will straighten out with further growth and re-modelling over the next 5 years. This should be carefully explained to the worried parents.

DISTAL RADIUS

- Check sensation: **median and ulnar nerve**
- Nerve injury more likely to occur with significant **angulation** of fragment or with significant **swelling**
- Examine elbow (supracondylar) and wrist (scaphoid)

DISTAL RADIUS FRACTURES

If child complaines from pain and there is tenderness is over growth plate in examination + x-rays are normal initially ⍰ immobilize for 2 weeks + Bring child back to re-examine and re-xray

⍰ If no callus, fracture is unlikely

Hip fractures in children

- These rare injuries are usually due to high-velocity trauma; for example, falling from a height or a car accident.
- In children under 2 years, the possibility of non-accidental injury considered.
- **Fractures through the middle and basal parts of the femoral neck are the most common**.
- Clinical features
- Diagnosis can be difficult in infants , where the epiphysis is not easily defined on x-ray.
- Ultrasonography & (MRI) may help.
- In older children the diagnosis is usually obvious on plain x-ray examination.
- It is important to establish whether the fracture is displaced or un-displaced .

- Treatment
- These fractures should be treated as a matter of urgency, and certainly within 24 hours of injury.
- Initially the hip is supported or splinted while investigations are carried out.
- Undisplaced fractures may be treated by immobilization in a plaster for 6–8 weeks. However, fracture position is not always maintained and there is a considerable risk of late displacement and malunion or non-union.
- Operative fixation may be needed.

Hip fractures in children

- Complications
- *Avascular necrosis of the femoral head*
  This is the most common (and most feared) complication. It occurs in about 30% of all cases

important risk factors are:

- (1) age of more than 10 years
- (2) high-velocity injury
- (3) a fracture through the proximal part of the femoral neck
- (4) fracture displacement.
- The child complains of pain and loss of movement; x-ray changes usually appear within 3 months of injury.

TIBIAL FRACTURE

- Tibia and fibula fractures often occur together
  - If you see a tibial fracture, hunt for a fibular one
  - Fibular fracture could be plastic deformity
- Mechanism: falls and twisting injury of the foot. Intact periosteum and support from fibula **prevent displacement commonly**

TIBIAL FRACTURE

FIGURE 15

Tibial fractures

Acute buckle fracture of the distal tibia with minimal angulation (A). Subtle greenstick fracture of the mid-tibia (B). A nondisplaced tibial shaft fracture (C).

TODDLER'S FRACTURES

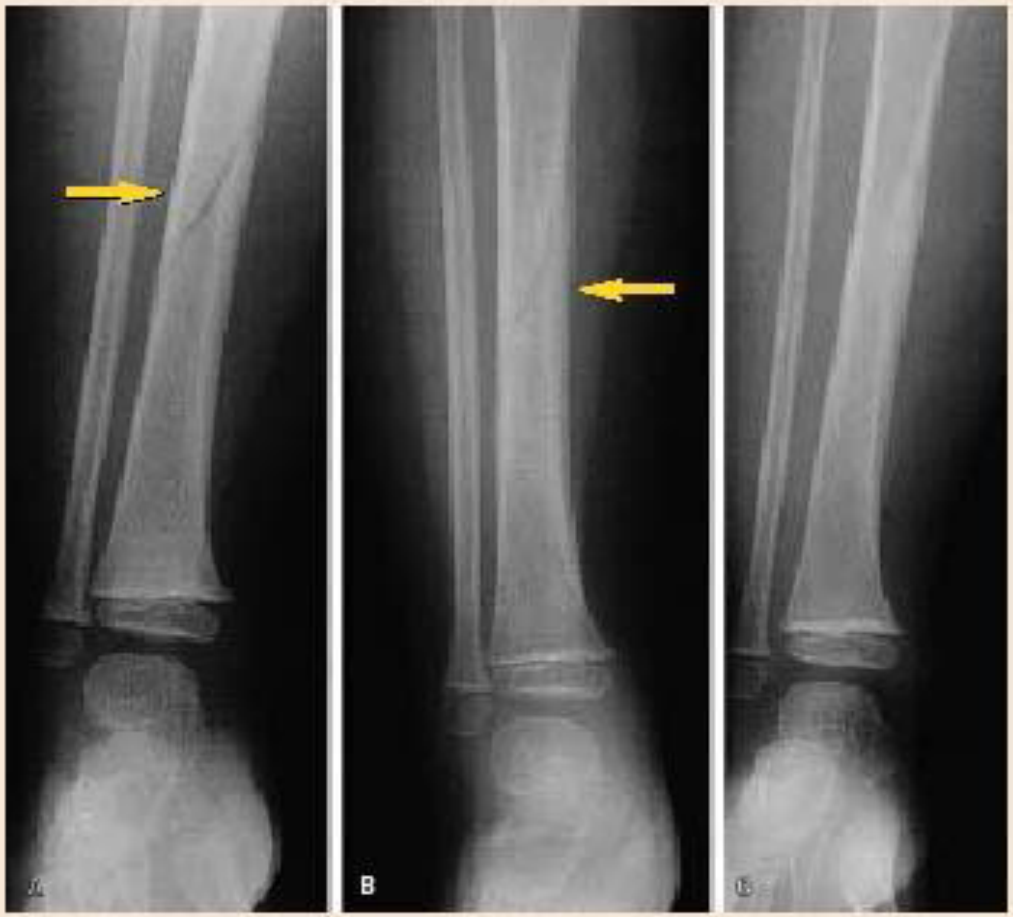
- Children younger than 2 years old learning to walk
- No specific injury notable most of the time
- Child refuses to bear weight on leg
- Examine hip, thigh and knee to r/o other causes of limping
- A **limp** is a type of asymmetric abnormality of gait. Limping may be caused by pain , weakness, neuromuscular imbalance, or a skeletal deformity.

TODDLER'S FRACTURES

- If you suspect it, get AP and lateral views of entire tib/fib area
- Typical: **nondisplaced spiral fracture of tibia with no fibular fracture**
- Initial x-ray often normal

FIGURE 16

Toddler's fracture



A nondisplaced spiral fracture of the mid-tibial shaft (A), the so-called toddler's fracture. Follow-up radiograph one month later (B) shows fracture healing. Radiograph two months after original injury (C) shows complete healing.

TODDLER'S FRACTURES

- Consider and rule out abuse
- Management: long leg cast x 3-4 weeks
- Weight bearing as tolerated
- Heals completely in 6-8 weeks

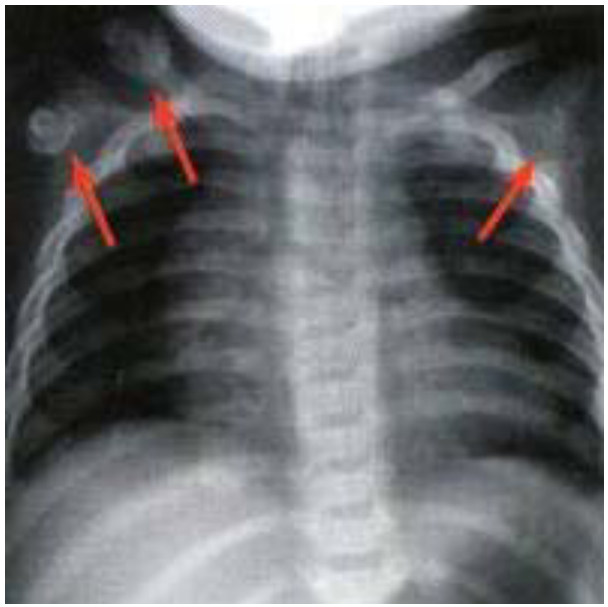
Spontaneous' fractures in children

- Fractures following minimal trauma may be due to unusual genetic disorders (e.g. osteogenesis imperfecta).
- You should keep in mind the possibility that they may be victims of deliberate injury .
- X-rays may show
- florid callus formation, mimicking the appearancesof osteomyelitis or scurvy.

Beware!
Child abuse !!

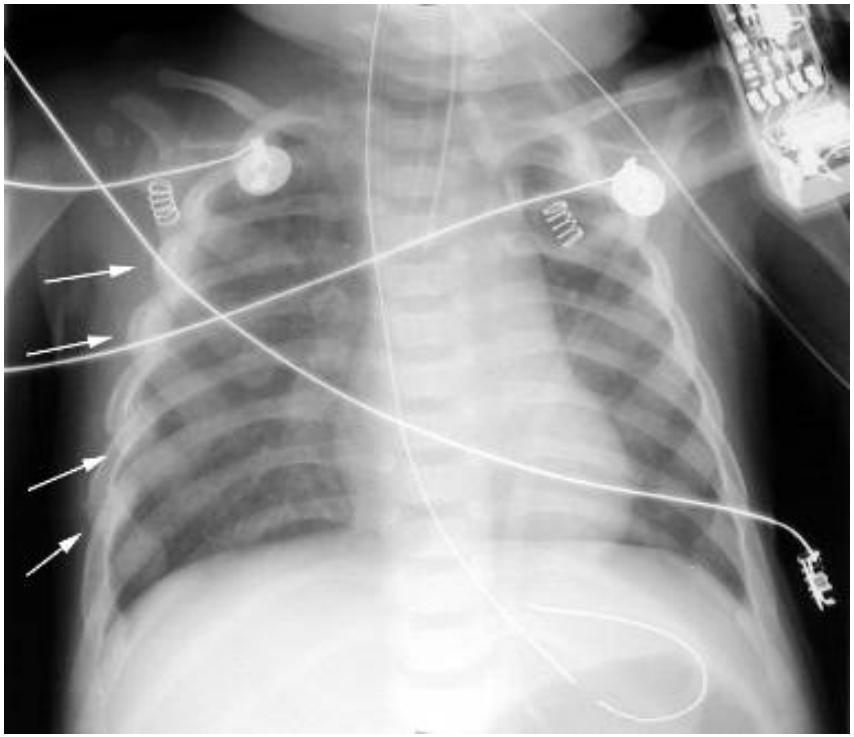
Non-accidental injuries

- **Multiple**
- **At various levels of healing**
- **Unclear history – mismatching with injury**
- **Circumstantial evidence**
- Soft tissue injuries - bruising, burns
- Intraabdominal injuries
- Intracranial injuries
- Delay in seeking treatment



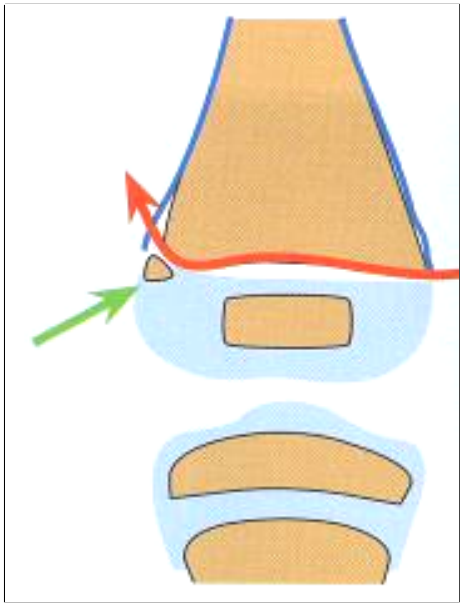
Beware!
Child abuse !!

- Specific pattern
  1. Posterior ribs
  2. Skull



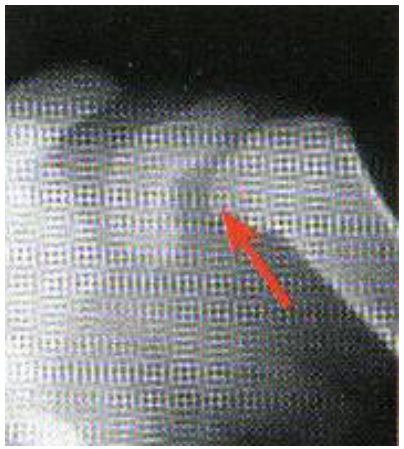
Beware!
Child abuse!!

- Specific pattern
  - 3. Corner fractures (traction & rotation)



Beware!
Child abuse !!

- Specific pattern
  - 4.Femur shaft fracture
    - <1 year of age (60-70% non accidental)
    - Transverse fracture
  - 5.Humeral shaft fracture <3 years of age



CONCLUSIONS

- Nearly 20% of children with injury have a fracture
- Consider bilateral X-rays in children
- Physeal injuries are common and may have no radiographic findings
- Don’t forget to tell Mom and Dad about possible growth problems
- Consider child abuse with high risk fractures