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Pediatric Fractures

Objectives:

- Difference between Ped & adult
- Physis → Salter-Harris classification
- Indications of operative treatment
- Methods of treatment of Ped # & trauma
- Common Ped #:

U.L → clavicle, humeral supracondylar, distal radius
L.L → femur shaft

References: Slides, Notes, Team 433, Toronto Notes, Appley's.

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Introduction

- Neonate (birth – 1 month)
- Infant (1 month- 2 years)
- Child (2 years – 12 years)
- Pediatric patient classification is arbitrary
- Boys are prone to break their bones more than girls.

Q: why are fractures in pediatrics special?

A: Bones are still growing.

This will only occur if the fracture is in the physis. they may not grow properly/ symmetrically e.g. Angular deformity, Leg length inequality.
Types of fractures

- **salter Harris classification**:

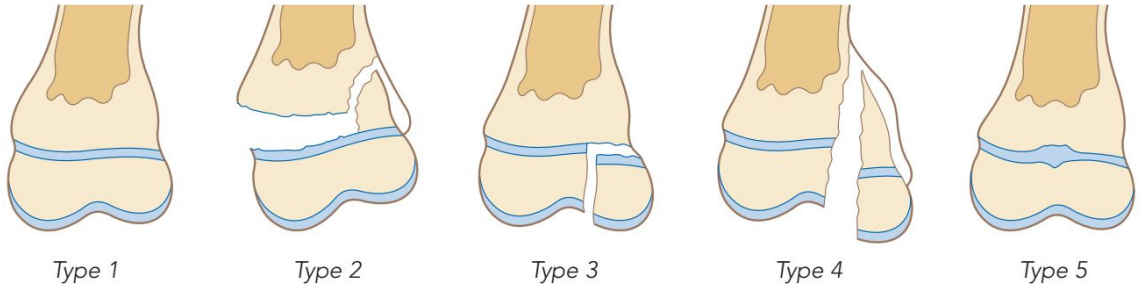
  - **Type 1**: a transverse fracture through the hypertrophic or calcified zone of the plate. Even if the fracture is quite alarming displaced, the growing zone of the physis is usually not injured and growth disturbance is uncommon.

  - **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**: as with Type 3, 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.**The worst Type.**



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.

- **Physeal bridging:** is a rare condition 1% where the bone stops growing due to trauma (fracture) or infection in the physis.

As we know you can't fracture the hall physeal plate, so the healthy part will keep growing and that will result in either valgus or varus.
Statistically small bridges and central bridges are more likely to lyse. While peripheral bridges are more likely to cause deformity.
- whenever you are doing a surgery make sure not to injure the physeal plate, and if you suspect it do MRI.

B: bones are easier to break

we know that greenstick fractures are more likely to occur in children and that's because of the bone composition, osteoid density is lesser in comparison with adults, and is loosely attached to tissue beneath.
Juvenile bone has more harversian canals (forms a network in bone which contains blood vessels).
As we mentioned that the children's bones have more harversian canals, which means better blood supply rare delayed and non-union in case of fractures (upside).

C: Hard to evaluate

x-ray is difficult to assess; articular fragments are often underestimated.
plate often mistaken for fracture on x-ray and vice versa (x-ray opposite limb for comparison especially in the elbow.

D: Ligaments are stronger than bones

Which means that an injury in the ligaments will most likely cause a bone fracture.

You can't tear something as strong as a ligament without affecting the bone which is vulnerable in that age due to density that we mentioned before.

Age related fractures:

Neonate → Diaphysis
Infant → Metaphysis
Child → epiphysis

Indications for surgery:

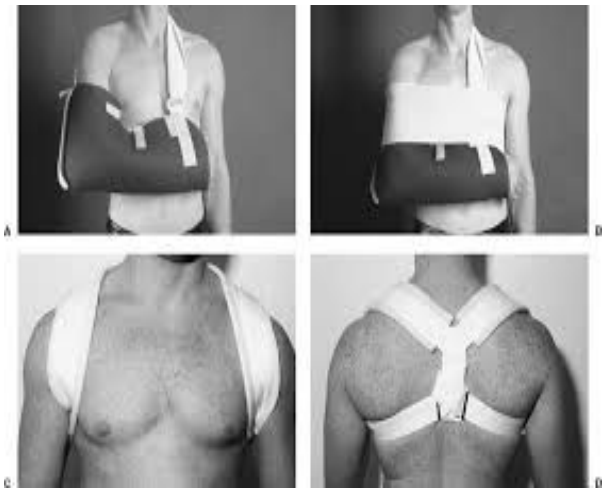
- Open fractures
- Severe soft-tissue injury
- Fractures with vascular injury
- Compartment syndrome
- Multiple injuries
- Displaced intra articular fractures (Salter-Harris III-IV)
- Failure of conservative means (irreducible or unstable #'s)
- Malunion and delayed union
- Adolescence
- Head injury
- Neurological disorder
- Uncooperative patient

Common pediatric fractures

Clavicle:

Incident:•8-15% of all pediatric

Bone	Treatment			Note
	Category	Treatment	Time	
clavicle	Newborn (< 28 days):	No orthotics. (artificial devices such as splints and braces.)	Unite within 1 week	The periosteal sleeve always remains in the anatomic position (remodeling is ensured)
	1 month – 2 years	Figure-of-eight	2 weeks	
	2 year– 12 year	Figure-of-eight or sling	2-4 weeks	



Humeral supracondylar:

•55-75% of all elbow

•M:F 3:2

•Age 5 - 8 years

•Left (non-dominant) side most frequently

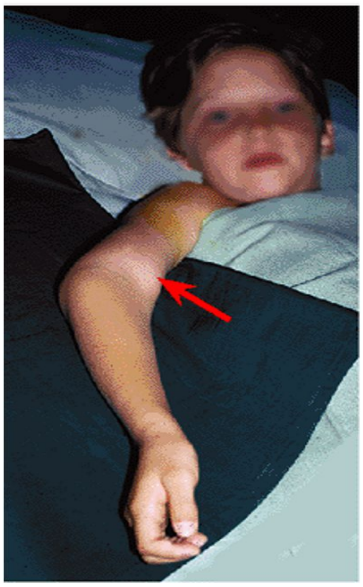
Bone	Treatment		
	Category	Treatment	Time
Humeral supracondylar	Type I	Above elbow cast (or splint)	3-6 weeks
	Type II	1- Closed reduction & above elbow casting 2- Closed reduction with percutaneous pinning (if: unstable or sever swelling), & above elbow cast (splint)	4-6 weeks
	Type III	closed reduction & percutaneous pinning if fails ORIF	4-6 weeks

Mechanism of injury :

- Indirect: Extension type, >95%
- Direct: Flexion type, < 3%

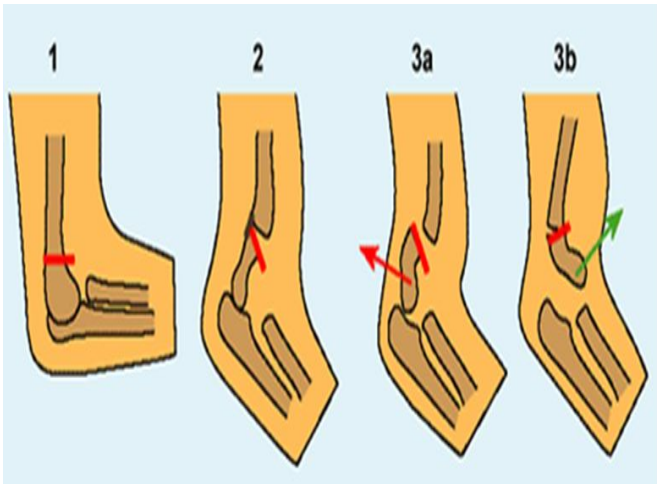
Following a fall, the child is in **pain** and the elbow is **swollen;** with a **posteriorly displaced fracture,** the **S-deformity** of the elbow is usually obvious. It is essential to **feel the pulse** and check the **capillary return.**

- **Look(Pain & Swelling)**
- **Feel & Move(it's difficult to do that)**
- **NV exam.**



Gartland Classification:[1]

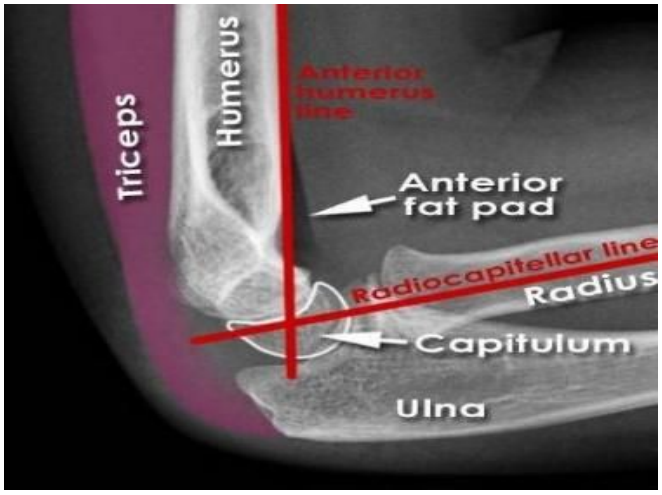
Type 1: No displacement.
Type 2: Minimal displacement.
Type 3: Complete displacement, if it's going backward
(3a): Extension fracture "indirect trauma"... Forward
(3b): Flexion fracture "direct trauma



[1] The Gartland classification is a system of **categorizing** supracondylar humerus fractures, clinically useful as it predicts the likelihood of **associated** neurovascular injury, such as anterior interosseous nerve neuropraxia or brachial artery disruption.

Type-III Complete displacement (extension type) may be:

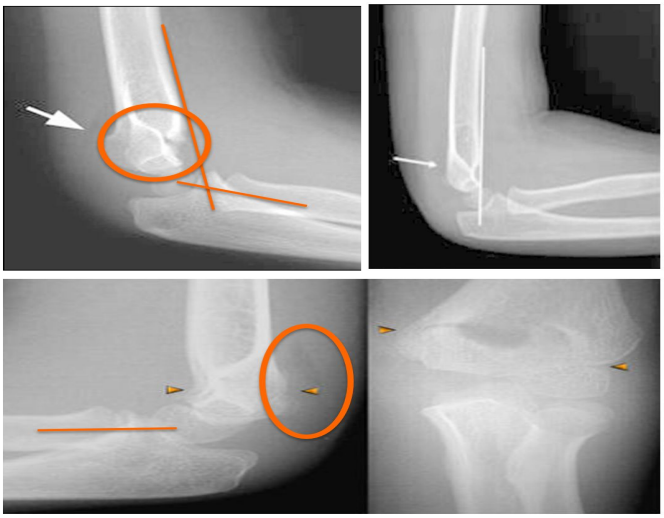
- Posteromedial (75%)
- Posterolateral (25%)



NOrmal Xray line

- **Anterior Humeral Line**
- **Hour-glass appearance**
- **Fat-pad sign**
- **Radio-capitellar line**

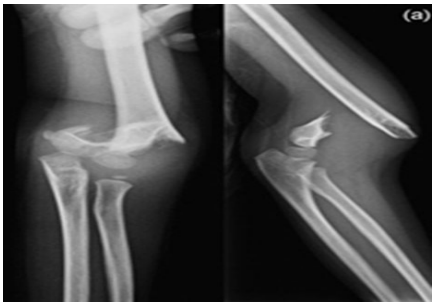
Type 1



- **Anterior Humeral Line**
- **Hour-glass appearance**
- **Fat-pad sign**
- **Radio-capitellar line**

Type 2

type 3



Humeral supracondylar Complications :

- Neurologic injury (7% to 10%):
    - Median and anterior interosseous nerves (most common)
    - Most are neuropraxias
    - Requiring no treatment

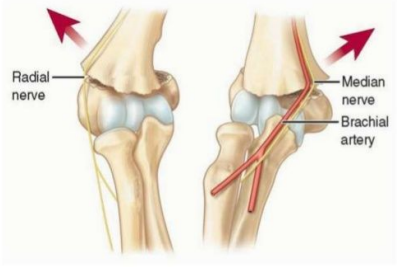


FIGURE 14-5 Relationship to neurovascular structures. The proximal metaphyseal spike penetrates laterally with posteromedially displaced fractures and places the radial nerve at risk; with posterolaterally displaced fractures, the spike penetrates medially and places the median nerve and brachial artery at risk.

- Vascular injury (0.5%):
    - Direct injury to the brachial artery, or
    - Secondary to swelling (compartment syndrome)

- Other:
    - Loss of motion (stiffness)
    - Myositis ossificans
    - Angular deformity (cubitus varus)

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.

Distal radius (Metaphyseal):

Bone	Types [2]	Management	
		Treatment	Time
Distal radius	Torus (buckle) → only one cortex is involved	Immobilized for pain relief in below elbow cast	2-3 weeks
	Incomplete (greenstick)	Closed reduction and above elbow cast	4-6 weeks
	Complete	1- Closed reduction, then well molded above elbow cast 2- **Or** open reduction and fixation (internal or external)	6-8 weeks

[2] The usual injury is a fall on the outstretched hand with the wrist in extension; the distal fragment is usually forced posteriorly (this is often called a 'juvenile Colles' fracture'). Lesser force may do no more than buckle the metaphyseal cortex (a type of compression fracture, or torus fracture).

Torus (buckle)

Incomplete

complete

Distal radius complications:

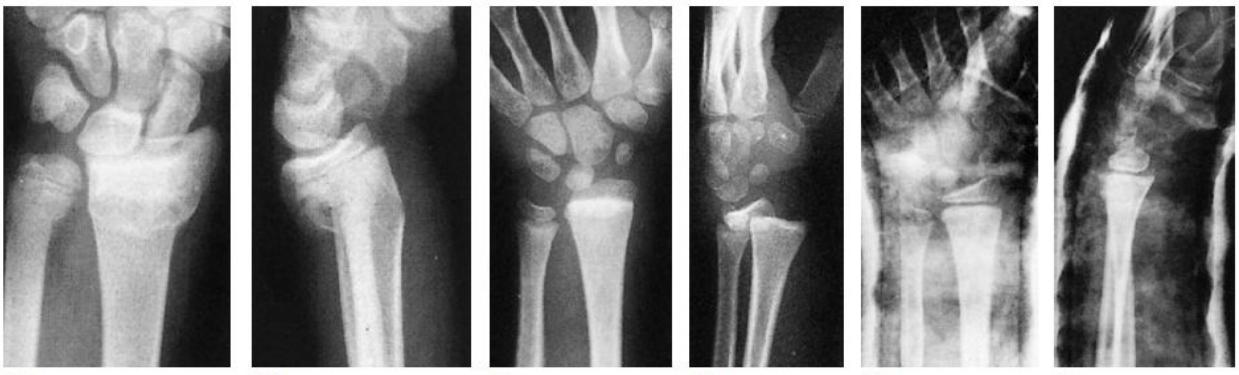
1- Malunion: Residual angulation may result in loss of forearm rotation
2- Nonunion ⟶ Rare
3- Refracture: With early return to activity (before 6 w)
4- Growth disturbance: Overgrowth or undergrowth
5- Neurovascular injuries: With extreme positions of immobilization

Distal Radius (Physis)[3]:

They follow the salter Harris classification

Type	Treatment	Complications
Type I and II	Closed reduction followed by above elbow cast	Growth arrest can occur in 25%
Type III	ORIF	Physeal arrest – Shortening – Angular deformity Ulnar styloid nonunion Carpal tunnel syndrome

this pic includes both meta and physeal, from appley.



(a) (b) (c) (d) (e) (f)

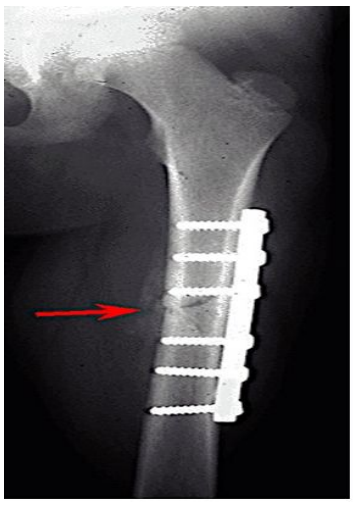
25.12 Distal forearm fractures in children (a,b) In older children the fracture is usually slightly more proximal than a true Colles', and often merely a greenstick or buckling injury. (c,d) In young children physeal fractures are usually Salter–Harris type I or II. In this case, accurate reduction has been achieved (e,f).

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

Femoral Shaft:

- 1.6% of all pediatric
- M > F
- Age:
  - (2 – 4) years years old
  - Mid-adolescence
  - Adolescence >90% due to RTA

Bone	Treatment		
	Category	Treatment	Time
Femoral Shaft	> 6 months	1- Pavlik Harness 2- Closed reduction & immediate hip spica casting Or traction then hip spica casting	1-2 weeks
	6 months- 6 years	Closed reduction & immediate hip spica casting (>95%) Or traction, then hip spica casting	1-2 weeks
	6 y -12 years	1- Flexible IMN 2- Plating 3- External Fixation: – Multiple injuries – Open # – Comminuted # – Unstable patient	-
	12y to skeletal maturity	Intramedullary fixation with either: – Flexible nails, or – Locked I.M.N	



Femoral Shaft Complications:

1- Malunion: Remodeling will not correct rotational deformities
2- Leg length discrepancy: Secondary to shortening or overgrowth
3- Muscle weakness
4- Nonunion (rare)

Methods of treatment:

- Never forget to check neurovascular status before and after any kind of management whether it's reduction or casting.

Type	Indication	Note
casting	Generally: acute fractures or sprains, or for initial stabilization of reduced, displaced, or unstable fractures before orthopedic intervention. Used to correct deformities especially in pediatrics	- Most common type - In infants we don't use cast, instead we use tongue depressor.
K-wires	1- Fractures in epi-/metaphyseal areas 2- Fractures of small bones (e.g. hand and foot) 3- Small bony fragments 4- For fragment reposition in multifragmentary fractures in addition to stable fixation	Most commonly used internal fixation (I.F) Usually used in ⟶ metaphyseal fractures
intramedullary wires	-	
screws	Are used for internal fixation more often than any other type of implant.	
plates	To hold broken pieces of bone together. Can be left after healing	
Intramedullary nailing	Closed Winquist types III and IV fractures, acute fractures, long oblique fractures, and closed reconstructive defects or malrotations.	Used in patients over 12 years.
ex-fixing	used as a temporary treatment for fractures. Because they are easily applied, external fixators are often put on when a patient has multiple injuries and is not yet ready for a longer surgery to fix the fracture.	
A combination could be used		

Casting

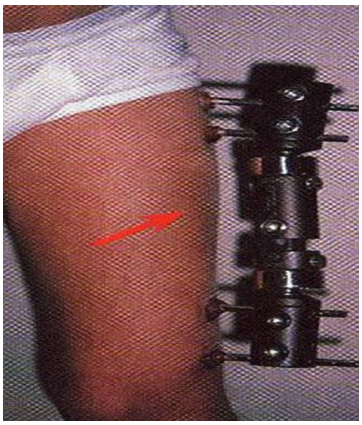
Plates

Kwires

IM nailing

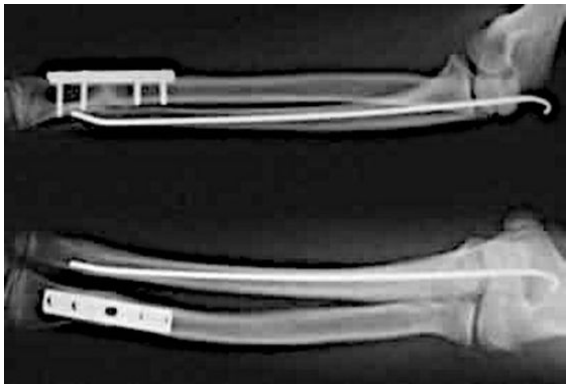
IM wires

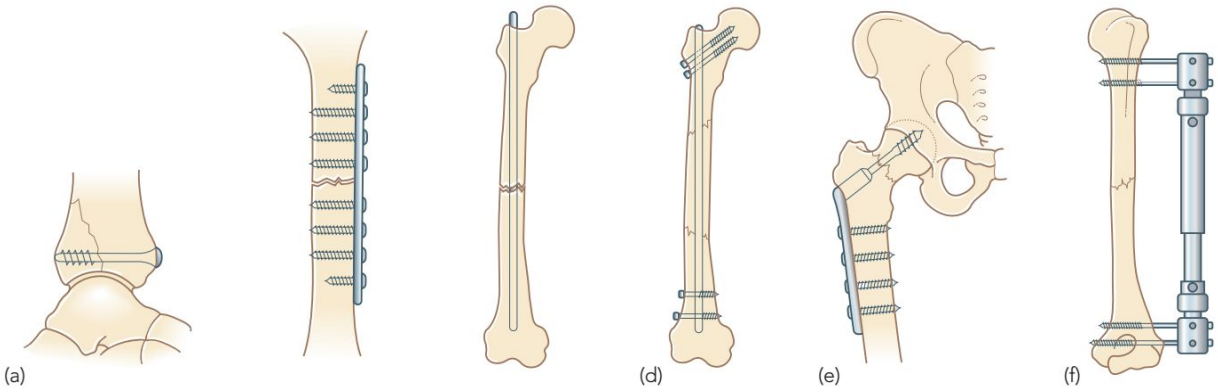
EX-fix



Screws

Combination





12.2 Bone fixation Several methods of fixation are used, depending on site and circumstances. (a) A lag screw for interfragmentory compression. (b) Plate and screws. (c) Intramedullary nail. (d) Locked intramedullary nail. (e) Dynamic hip screw. (f) External fixator.