



433 Teams
ORTHOPEDICS

Lecture 13

**Common Pediatrics
Fractures**

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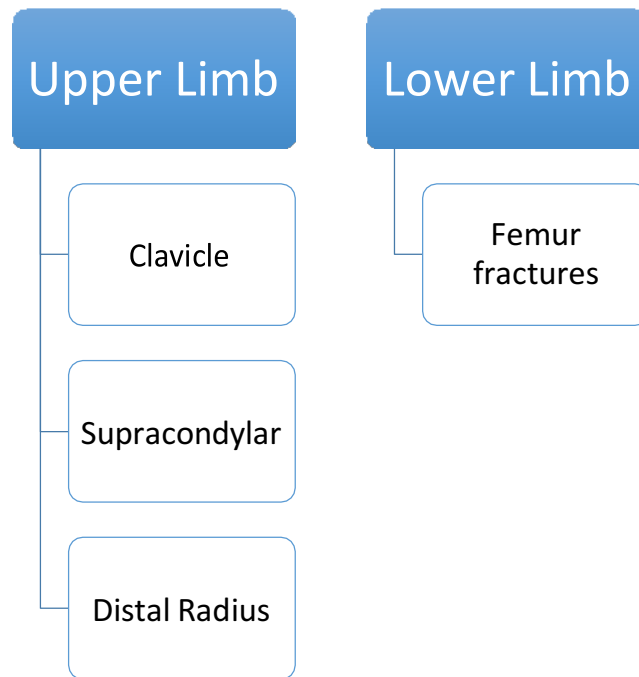
جامعة
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Objectives

Not given.

Mind Map:



Introduction

- Vary in various age groups (Infants, children, adolescents).
- Different from adult fractures.

Statistics:

- Boys > girls.
- Rate increases with age." Age is important in the MCQs"

Why are children's fractures different?

Children have different physiology and anatomy.



Growth plate

- Provides perfect remodeling power.
- Injury of growth plate causes deformity.
- A fracture might lead to overgrowth.

- In the picture " lateral side is arrested and medial is continue to grow " genu valgus deformity"



Bone

- Increased collagen:bone ratio.
- Less brittle.
- Deformation.

- Picture shows the cortex and periosteum are intact, It's not a fracture it called plastic deformation
- The younger the patient the more you will see this.



Cartilage

- Difficult x-ray evaluation.
- Size of articular fragment often *under-estimated*.

- We always operate if it involves the lateral condyle because the size of fracture is underestimated



Periosteum

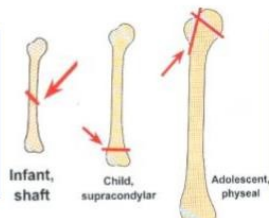
- Metabolically active:
 - More callus, rapid union, increased remodeling.
- Thickness and strength:
 - Intact periosteal hinge affects fracture pattern.
 - May help reduction.

- We don't see it in adult only pediatric



Ligaments

- Ligaments in children are functionally stronger than bone. Therefore, a higher proportion of injuries that produce sprains in adults result in fractures in children.
 - You'll never hear a child with ACL tear

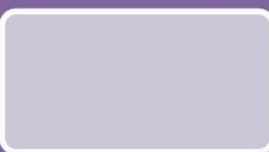


Age related fracture pattern

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

Commonly the fracture will be in:

- Diaphysis in infants
- Metaphysis in Children
- Epiphysis in adolescent



Physiology

- Better blood supply.
- Rare incidence of delayed and non-union.

Examples: we only realign the bone then apply casting, NO SURGERY.



Fracture in the
Femur

Big callus
Formed

Remodeling

Union happened



Fracture in the humerus in
a newborn

Fracture in the humerus

*In infants we don't use cast, instead we use tongue depressor.

*Fractures near to a joint that moves everywhere (shoulder) and near to epiphysis → Better for remodeling.

Physeal (Growth Plate) injuries:

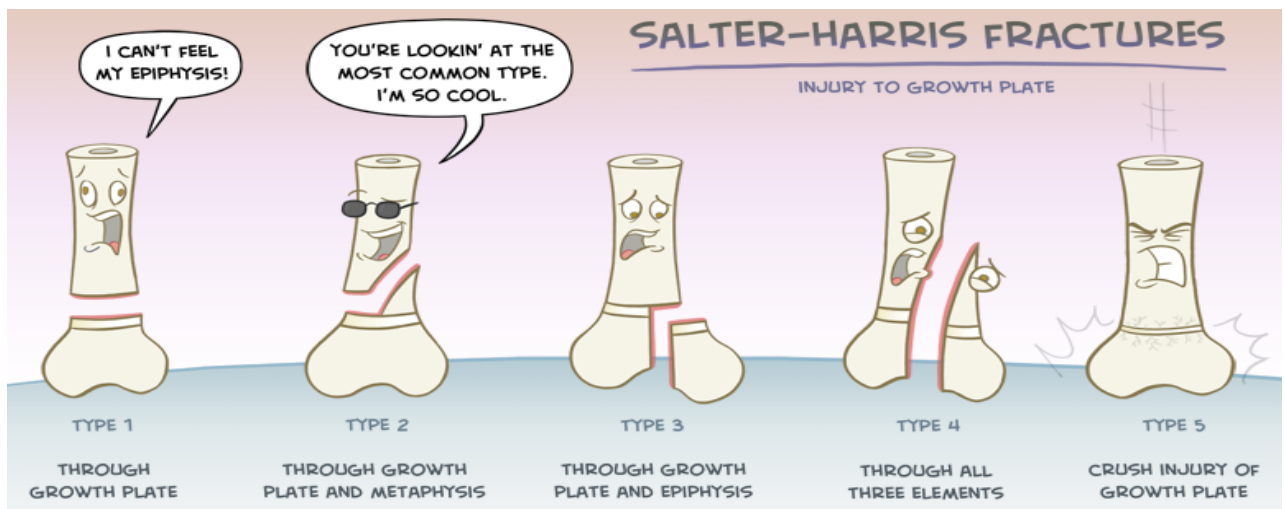
- Account for ~25% of all children's fractures.
- More in boys.
- More in upper limb.
- Most heal well rapidly with good remodeling.
- Growth may be affected.

Classifications:

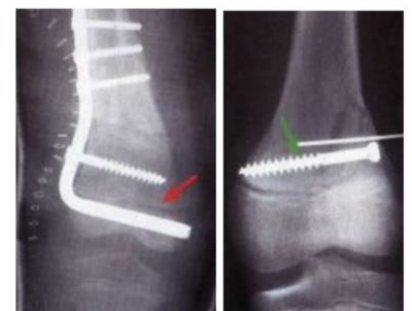


Salter-Harris

- ✓ Type I: Through the growth plate. It doesn't appear on the x-ray, so usually request an x-ray to the other side
- ✓ Type II: Growth plate with metaphysis
- ✓ Type III: Growth plate with epiphysis. "Intra-articular", one of the complication is premature osteoarthritis
- ✓ Type IV: Growth plate with metaphysis and epiphysis
- ✓ Type V: Compression



- Less than 1% cause physeal bridging affecting growth (Varus, valgus, leg length inequality).
- Small bridges (<10%) may lyse spontaneously.
- Central bridges more likely to lyse.
- **Peripheral bridges more likely to cause deformity**
- Avoid injury to pphysis during fixation.
- Monitor growth over a long period.
- Image suspected physeal bar (CT, **MRI**).




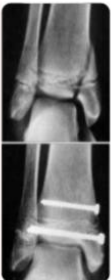






Type IV. Corrected with K-wire and screw.

General Management Indications for surgery:

- Head injury. “Because they’ll develop lot of callus”
- Multiple injuries.
- Open fractures.
- Displaced intra articular fractures (Salter-Harris III-IV).
- Adolescence.
- Failure of conservative means (irreducible or unstable fractures).
- Severe soft-tissue injury or fractures with vascular injury.
- Neurological disorder.
- Malunion and delayed union.
- Compartment syndrome. “It depends when the patient came to the hospital “6 golden hours “

Methods of fixation

Casting	K-wires *	Intramedullary wires, elastic nails.	Screws	Plates	IMN ** Intramedullary nail	Ex-fix	Combination
Still the commonest	Most commonly used IF “internal fixation” Metaphyseal fractures.			Multiple trauma	Adolescents not all children because of epiphysis	Usually in open fractures	
							

*Inserted percutaneously in OP under GA.

** Above 12 years because the greater trochanter growth plate is near to the entry point of piriformis fossa. So, the older the child the less chance to have AVN.

Common Pediatric Fractures:

- Upper Limb: Clavicle, Supracondylar Fracture, Distal Radius.
- Lower Limbs: Femur fractures.

Fracture Clavicle

- Happens in extreme ages (children and old age).
- 8-15% of all pediatric fractures.
- 0.5% of normal deliveries and in 1.6% of breech deliveries.
- 90% of obstetric fractures.
- 80% of clavicle fractures occur in the shaft.
- The periosteal sleeve always remains in the anatomic position. Therefore, remodeling is ensured.
- We should check neurovascular and pulmonary function status.
- AP view on x-ray is enough.

Mechanism of Injury:

- **Indirect:** Fall onto an outstretched hand.
- **Direct:** This is the **most common mechanism**, it carries the highest incidence of injury to the underlying neurovascular and pulmonary structures.
- Birth injury.

Clinical Evaluation:

- Painful palpable mass along the clavicle, Pain comes from the periosteum because it is innervated
- Tenderness, crepitus “We don’t do crepitus clinically, it’s painful”, ecchymosis swelling and tinting of skin
- May be associated with neurovascular injury.
- Pulmonary status must be assessed.
- Radiographic Evaluation: AP view

Radiographic Evaluation: AP view

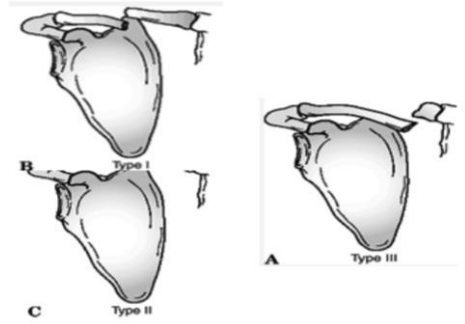


Classification:

- Location.
- Open or closed.
- Displacement.
- Fracture type: Segmental, comminuted, greenstick.

Allman classification:

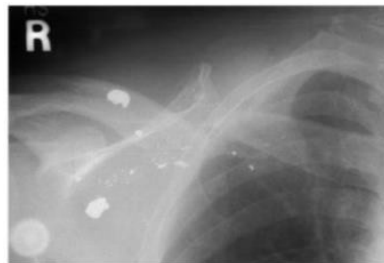
- Type I: Middle third **most common**
- Type II: Lateral third
- Type III: Medial third

**Treatment:** “easily treated if there’s no N/V or pulmonary injury”

- Newborn:
 - **Do nothing just secure it in place** it will unite in 1 week.
- Up to 2 years:
 - Figure-of-eight for 2 weeks
- Age 2-12 Years:
 - A figure-of-eight or sling for 2-4 weeks.

**Indications of operative treatment:**

- Open Fracture.
- Neurovascular Compromise.

**Complications “Rare”**

- Neurovascular compromise
- Malunion
- Nonunion
- Pulmonary injury.

Supracondylar Humeral Fracture

- 55-75% of all elbow fractures.
- The male-to-female ratio is 3:2.
- 5 to 8 years.
- The left, or nondominant side, is most frequently injured.

Mechanism of Injury:

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

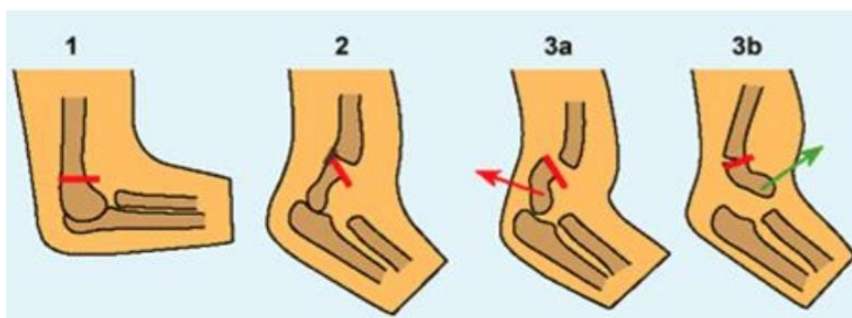
Clinical Evaluation:

- Swollen, tender elbow with painful ROM.
- S-shaped angulation.
- **Pucker sign (dimpling of the skin anteriorly).**
- Neurovascular examination:
 - Nerves: Median, radial, and ulnar nerves as well as their terminal branches.
 - The commonest nerve to be injured is:
 - Anterior interosseous nerve, which is branch from the median nerve and it is associated more with extension.
 - The way to assess: ask the patient to do (ok) sign.
 - Vascular: Brachial. Capillary refill and distal pulses should be documented.



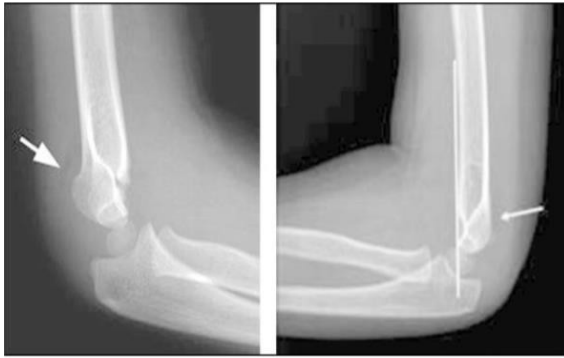
Classification (Gartland)

“Radiological classification”



- 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”.

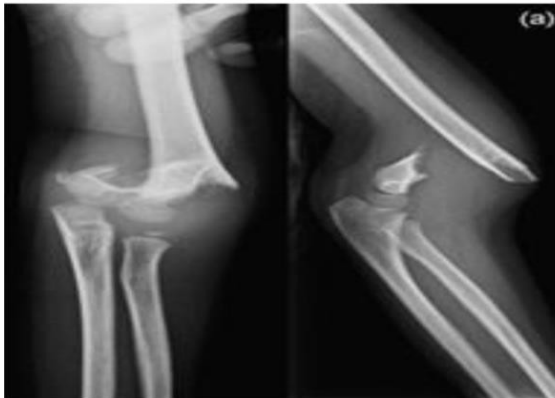
Complete displacement (extension type) may be posteromedial (75%) or posterolateral (25%).



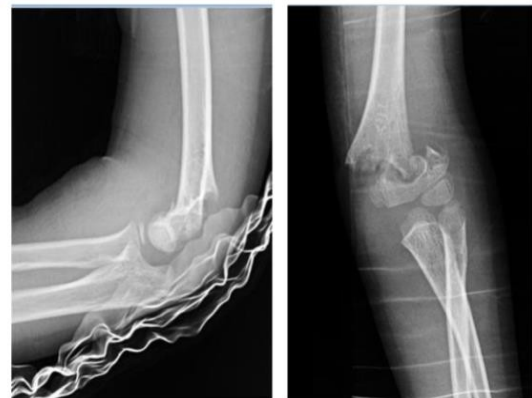
Type 1



Type 2



Type 3 (Extension)



Type 3 (Flexion)

Treatment of Extension type:

- **Type I:** Immobilization in a long arm cast or splint at 60 to 90 degrees of flexion for 2 to 3 weeks.
- **Type II:** Closed reduction followed by casting or **Percutaneous pinning using k wire** If unstable or sever swelling.
- **Type III:**
 - Attempt **closed reduction** and pinning.
 - Open reduction and **internal fixation** may be necessary for
 - unstable fractures, open fractures, or those with neurovascular injury. * **Ulnar nerve injury happens with pinning.** *



Treatment of Flexion type:

- **Type I:** Immobilization in a long arm cast in near extension for 2 to 3 weeks.
- **Type II:** Closed reduction followed by percutaneous **pinning**.
- **Type III:** Reduction is often difficult; most require open reduction and **internal fixation** with crossed pinning.

Complications:

- Neurologic injury (7% to 10%)
 - Most are neurapraxias requiring no treatment.
 - Median and anterior interosseous nerves (**most common**).
- Vascular injury (0.5%)
 - Direct injury to the brachial artery or secondary to swelling
- Loss of motion. “**Stiffness at elbow joint**”
- Myositis ossificans. “Ossification that occurs in muscles. Bone in muscles → Complete stiffness”
- Angular deformity (**cubitus varus**).
- Compartment syndrome.



Distal Radius Fractures

1. Distal Radius Physeal Injuries



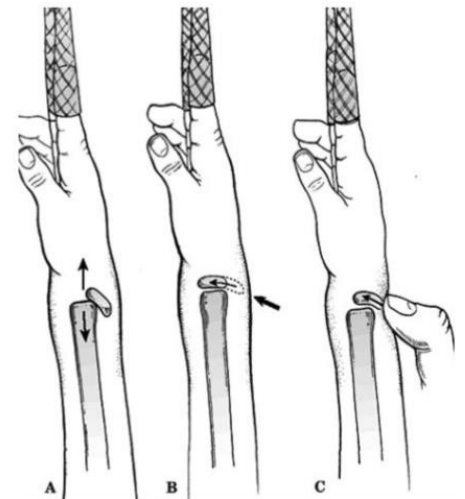
Type 1

Type 2

Type 3

Treatment:

- **Salter-Harris Types I and II**
- Closed reduction followed by long arm cast with the forearm pronated.
- **Immobilization**
- 50% apposition with no angular or rotational deformity is acceptable.
- Growth arrest can occur in 25% with repeated manipulations.
- **Open reduction is indicated**
 - Irreducible fracture.
 - Open fracture.



- **Salter-Harris Type III**
 - Anatomic reduction is necessary.
 - ORIF with smooth pins or screws.
- **Salter-Harris Types IV and V**
 - Rare injuries.
 - Need ORIF. *ORIF = Open Reduction Internal Fixation

Complications:

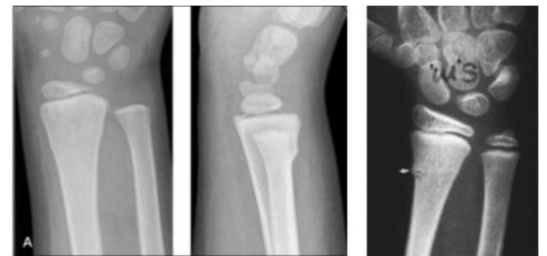
- Physeal arrest:
 - Shortening.
 - Angular deformity, **we do MRI to assess.**
- Ulnar styloid nonunion.
- **Carpal tunnel syndrome.**

**2. Distal Radius Metaphyseal Injuries****Classification:**

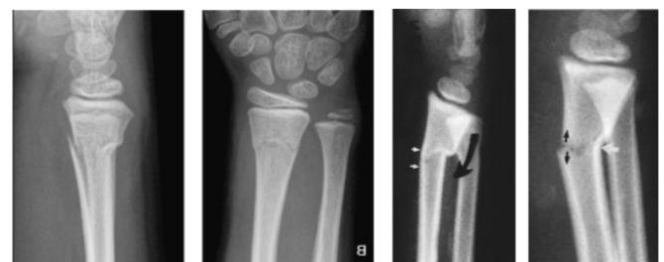
- We accept more angulation in pediatrics, the younger the child the more angulation we accept.
- Direction of displacement.
- Involvement of the ulna.
- Biomechanical pattern
 - Torus (only one cortex is involved)
 - Incomplete (greenstick)
 - Complete

Torus (only one cortex is involved):

- Periosteum is intact.
- The injury is stable.
- Protected **immobilization** for pain relief.
- Bicortical injuries should be treated in a long arm cast.

**Incomplete (greenstick):**

- Greater ability to remodel in the sagittal plane.
- **Closed Reduction** and above elbow **Cast** with supinated forearm
“Anatomical position” to relax the brachioradialis muscle. “

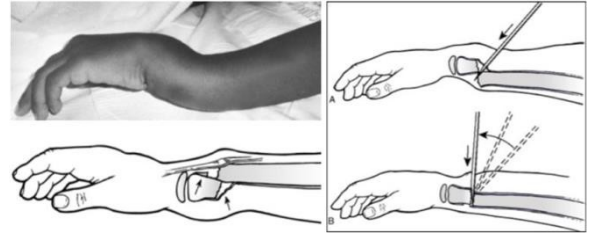
**Complete fracture:**

- Closed reduction.
- Well molded long arm cast for 3 to 4 weeks.



Indications for percutaneous pinning without open reduction:

- Loss of reduction.
- Excessive swelling.
- Floating elbow. “Fractured radial, ulnar and humerus”
- Multiple manipulations.



Indications for ORIF:

- Irreducible fracture.
- Open fracture.
- Compartment syndrome.



Complications:

- Malunion: Residual malangulation of more than 20% may result in loss of forearm rotation.
- Nonunion – rare.
- **Refracture**: an early return to activity (before 6 weeks). “It need surgery”
- Growth disturbance: (overgrowth or undergrowth). 3mm/9-12Y.
- Neurovascular injuries: avoid extreme positions of immobilization.

Femoral Shaft Fractures

- 1.6% of all pediatric fractures.
- Boys > girls.
- 2 to 4 years of age, mid-adolescence.
- In children younger than walking age, 80% of these injuries are caused by **child abuse**; this decreases to 30% in toddlers.
- In adolescence, >90% due to **RTA**.

Mechanism of Injury:

- Direct trauma: RTA, fall, or child abuse.
- Indirect trauma: Rotational injury.
- Pathologic fractures: Osteogenesis imperfect **العظم الزجاجي**, nonossifying fibroma, bone cysts, and tumors.
- **How to know if it's direct or indirect from x-ray? Transverse and comminuted fractures are direct; the spiral is indirect.**

Clinical Evaluation:

- Pain, swelling, inability to ambulate, and variable gross deformity.
- Careful neurovascular examination is essential.
- Careful examination of the overlying soft tissues to rule out the possibility of an open fracture.

Radiographic Evaluation:

- AP and lateral views.
- Must include hip, knee joints.



Classification:

- Descriptive:
 - Open versus closed.
 - Level of fracture: proximal, middle, distal third.
 - Fracture pattern: transverse, spiral, oblique, butterfly fragment.
 - Comminution.
 - Displacement.
 - Angulation.
- Anatomic:
 - Subtrochanteric Shaft.
 - Supracondylar.

Treatment: Less than 6 Months

- Pavlik harness:
- Traction For 2 week then spica casting



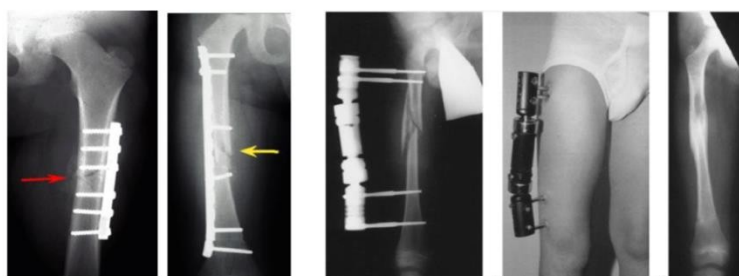
6 Months to 4 Years

- Closed reduction and immediate casting (>95%).
- Traction followed by spica casting if there is difficulty to maintain length and acceptable alignment.



6 to 12 Years

- Flexible IMN.
- Bridge Plating.
- External Fixation
 - Multiple injuries
 - Open fracture
 - Comminuted
 - Unstable patient



12 Years to Maturity

- Intramedullary fixation with either flexible or interlocked nails
 “interlocked nails prevent rotation”.



Operative Indications:

- Multiple trauma, including head injury.
- Open fracture.
- Vascular injury.
- Pathologic fracture.
- Uncooperative patient.

Complications:

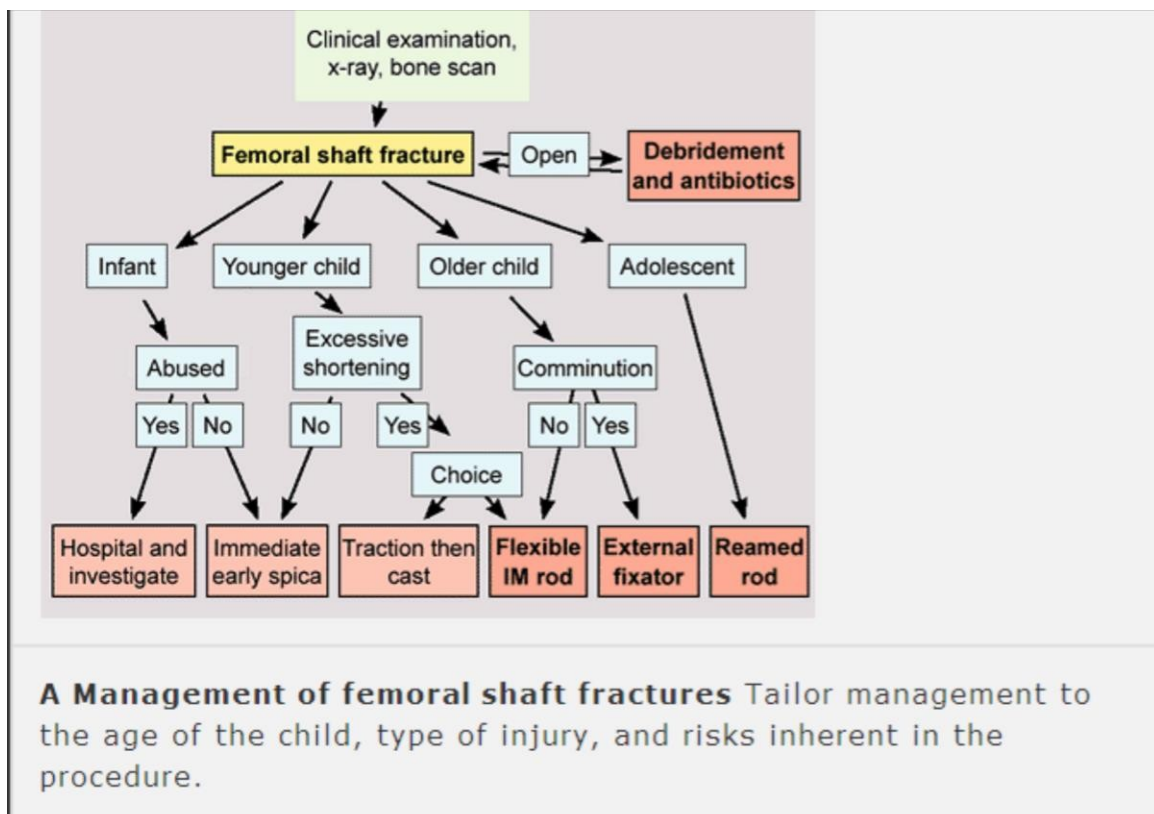
- Malunion: Remodeling will not correct rotational deformities.
- Nonunion (Rare).
- Muscle weakness.
- **Leg length discrepancy:**
 - Secondary to shortening or overgrowth.
 - Overgrowth of 1.5 to 2.0 cm is common in 2-10 year of age.
- Osteonecrosis with antegrade " it means from knee and above" IMN <16 year.

Table 48.1. Acceptable angulation

Age	Varus/Valgus (degrees)	Anterior/Posterior (degrees)	Shortening (mm)
Birth to 2 y	30	30	15
2â€"5 y	15	20	20
6â€"10 y	10	15	15
11 y to maturity	5	10	10

Summary

- Why are children's fractures different?
Children have different physiology and anatomy.
- Physeal Classification: Salter-Harris
- Indications for surgery:
 - Head injury.
 - Multiple injuries.
 - Open fractures.
 - Displaced intra articular fractures (Salter-Harris III-IV).
 - Adolescence.
 - Failure of conservative means (irreducible or unstable fractures).
 - Severe soft-tissue injury or fractures with vascular injury.
 - Neurological disorder.
 - Malunion and delayed union.
 - Compartment syndrome.
- Methods of Fixation:
 - Casting
 - K-wires
 - Intramedullary wires, elastic nails.
 - Screws
 - Plates
 - IMN Intramedullary nail
 - Ex-fix
 - Combination
- Common Pediatric Fractures:
 - Upper limb: Clavicle, Supracondylar Fracture, Distal Radius.
 - Lower Limbs: Femur fractures.



MCQs

Q1: What are the common fracture pattern in Infants?

- A. Infants: diaphyseal fractures
- B. Infants: metaphyseal fractures
- C. Infants: epiphyseal injuries

Q2: What are the most important systems you have to check in Clavicle Fracture?

- A. Neurovascular
- B. Pulmonary function
- C. a & b

Q3: What are the most common type of Clavicle Fracture?

- A. Type I: Middle third
- B. Type II: lateral third
- C. Type III: Medial third

Q4: What is the cause of Femoral Shaft Fractures in children younger than walking age?

- A. Child abuse.
- B. RTA.
- C. Birth injury.

Q5: Bicortical injuries should be treated as?

- A. In a long arm cast.
- B. Closed reduction followed by percutaneous pinning.
- C. Reduction.

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