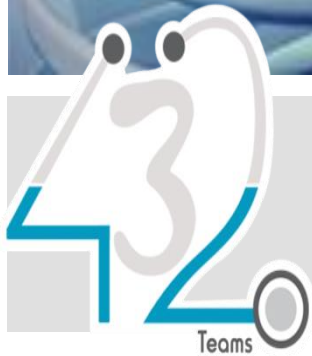
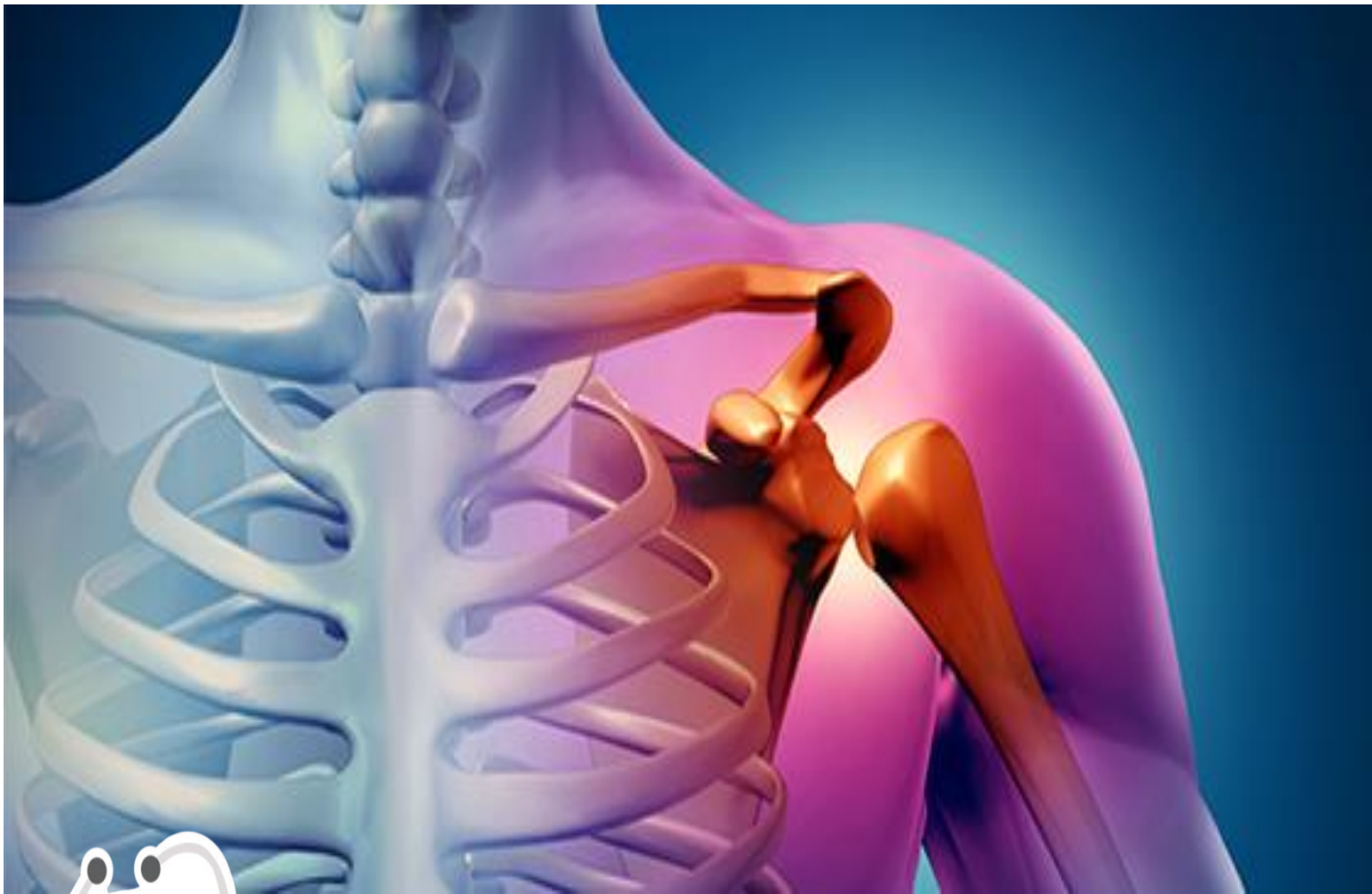


Orthopedics

432 Team

8 Common Pediatric Fractures



1st Edition:

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Color Code:

Slides

431 team work

Doctor's Notes

Arabic Words

Team Notes

Books' notes

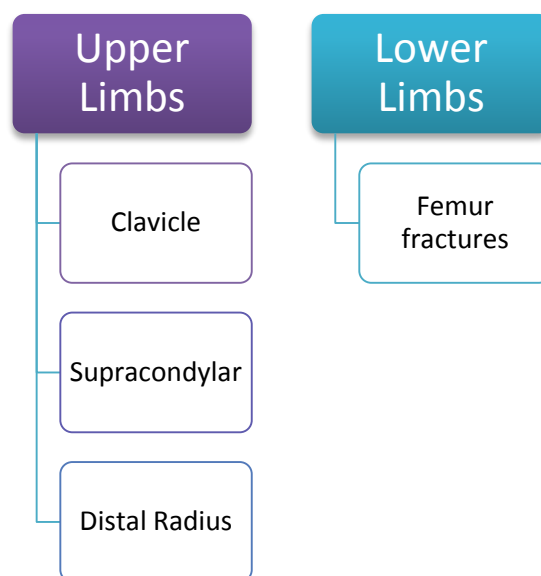
Important

Other Sources

Objectives

Not Given

Mind Map

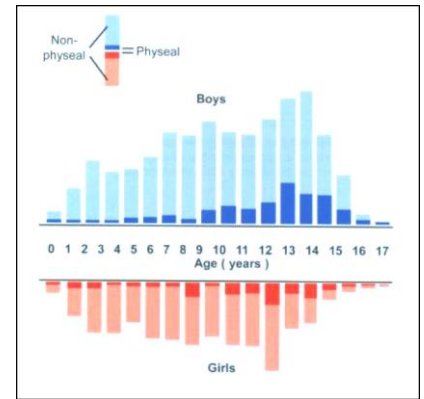


Introduction

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

Statistics:

- Boys > girls
- Rate increases with age



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.



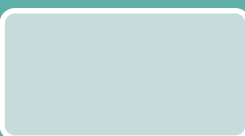
Bone

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



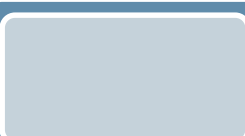
Cartilage

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



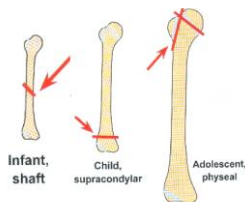
Periosteum

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



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.



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 and did casting, no surgery.



Fracture in 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:

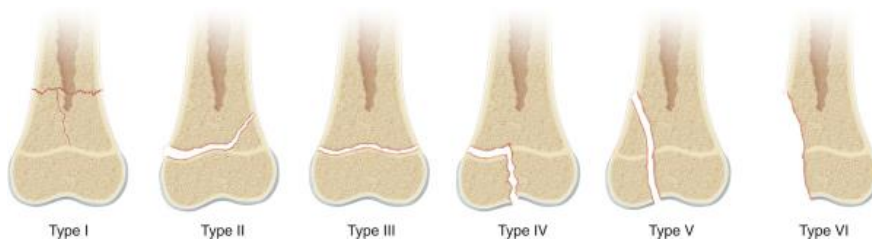
- Account for ~25% of all children's fractures.
- More in boys.
- More in upper limb.
- Most heal well rapidly with good remodeling.
- Growth may be affected.

Classification:



Salter-Harris

- Type I: Through the growth plate.
- Type II: Growth plate with metaphysis
- Type III: Growth plate with epiphysis
- Type IV: Growth plate with metaphysis and epiphysis

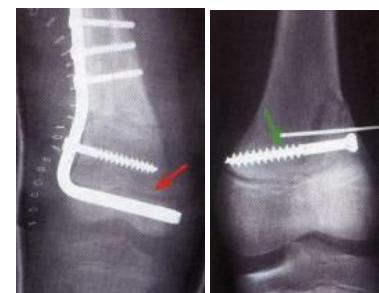


Peterson



Ogden

- * Less than 1% cause physeal bridging affecting growth.
- * Small bridges (<10%) may lyse spontaneously.
- * Central bridges more likely to lyse.
- * Peripheral bridges more likely to cause deformity
- * Avoid injury to physis 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.
- **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
Still the commonest	Most commonly used IF "internal fixation" Metaphyseal fractures.			Multiple trauma	Adolescents not all children because of epiphysis	Usually in open fractures	
							

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.
- Tenderness, crepitus "We don't do crepitus clinically, it's painful", and ecchymosis swelling.
- May be associated with neurovascular injury.
- Pulmonary status must be assessed.

Radiographic Evaluation: AP view

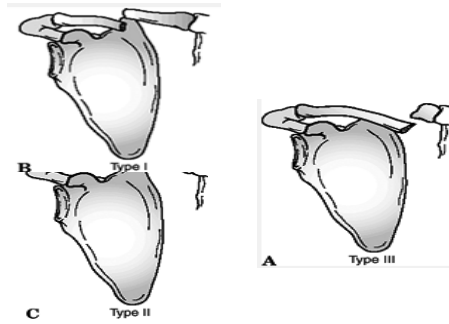


Classification:

- 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 fractures.
- Neurovascular compromise.



Complications: are 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:

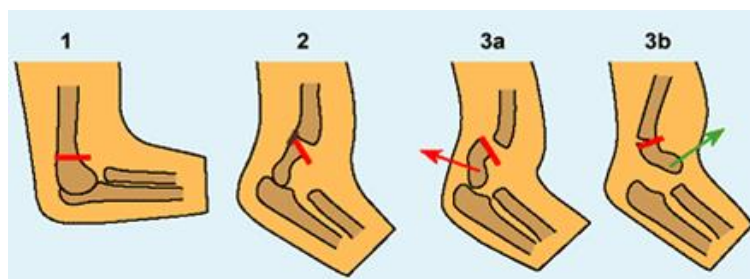
- Indirect: Extension type >95%.
- Direct: Flexion type < 3%.

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.

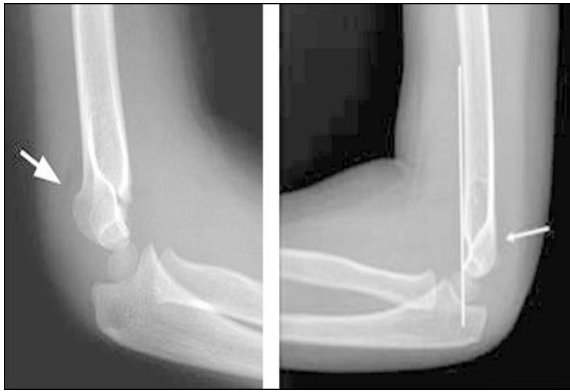


Classification (**Gartland**)



- 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".

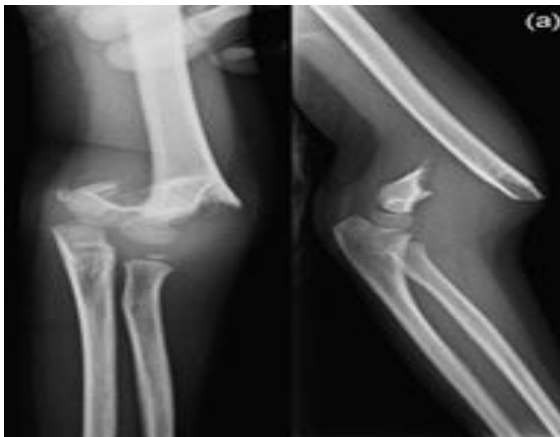
Complete displacement (extension type) may be posteromedial (75%) or posterolateral (25%).



Type 1



Type 2



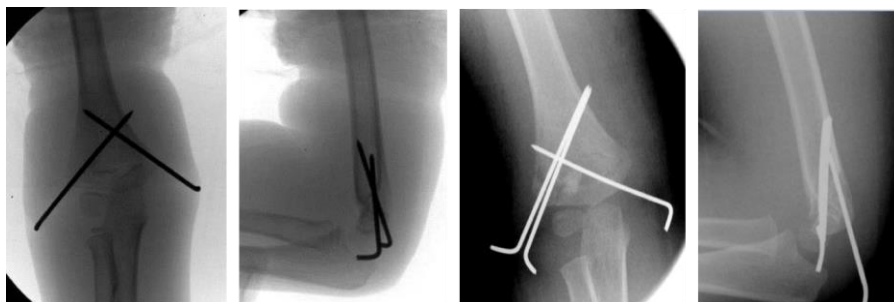
Type 3 (Extension)



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** pinning **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%)
 - a. Most are neurapraxias requiring no treatment.
 - b. Median and anterior interosseous nerves (most common).
- Vascular injury (0.5%)
 - a. Direct injury to the brachial artery or secondary to swelling
- Loss of motion.
- 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



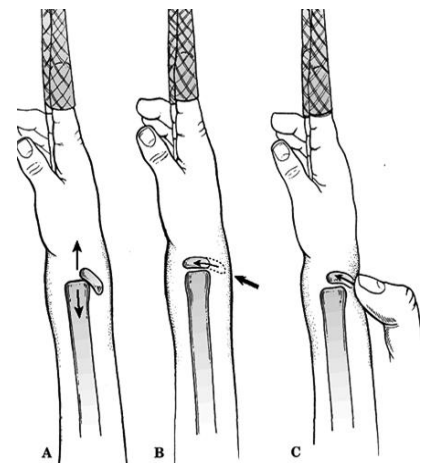
Type 2



Type 3

Treatment:

- **Salter-Harris Types I and II**
 - Closed reduction followed by long arm cast with the forearm pronated.
 - 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**
 - a. Anatomic reduction is necessary.
 - b. ORIF with smooth pins or screws.
- **Salter-Harris Types IV and V**
 - a. Rare injuries.
 - b. 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**.



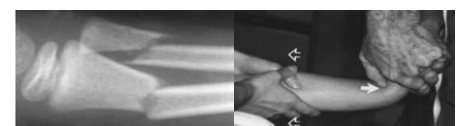
Incomplete (greenstick):

- ✓ Greater ability to remodel in the sagittal plane.
- ✓ **Closed reduction** and above elbow **cast** with supinated forearm to relax the brachioradialis muscle.



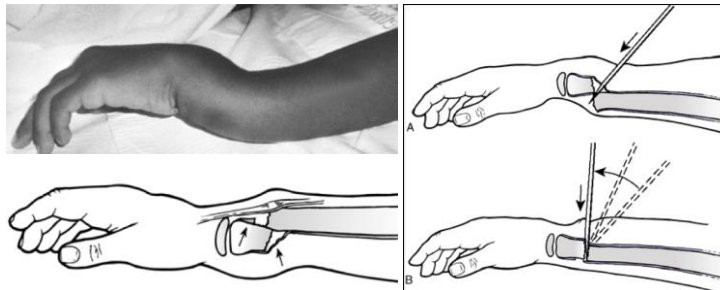
Complete fracture:

- ✓ **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.
- 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).
- 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 imperfecta, 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 and spica casting:



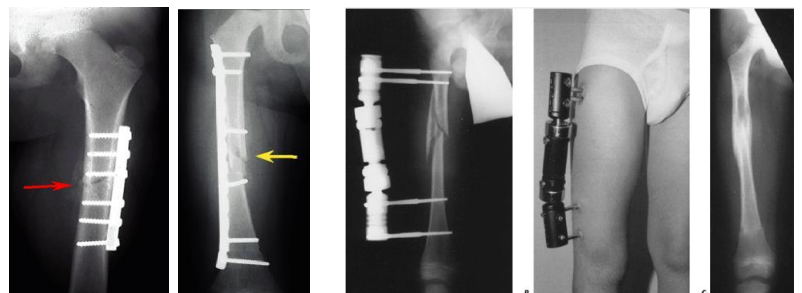
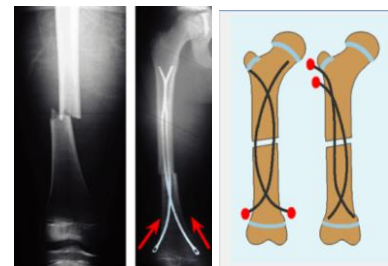
6 Months to 4 Years

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



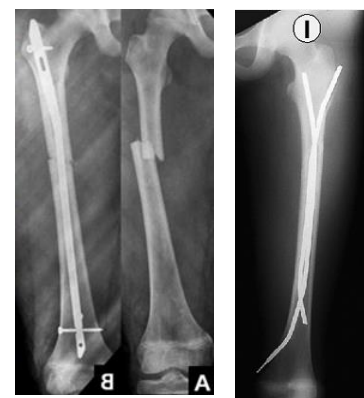
4 to 12 Years

- 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 IMN <16 year.

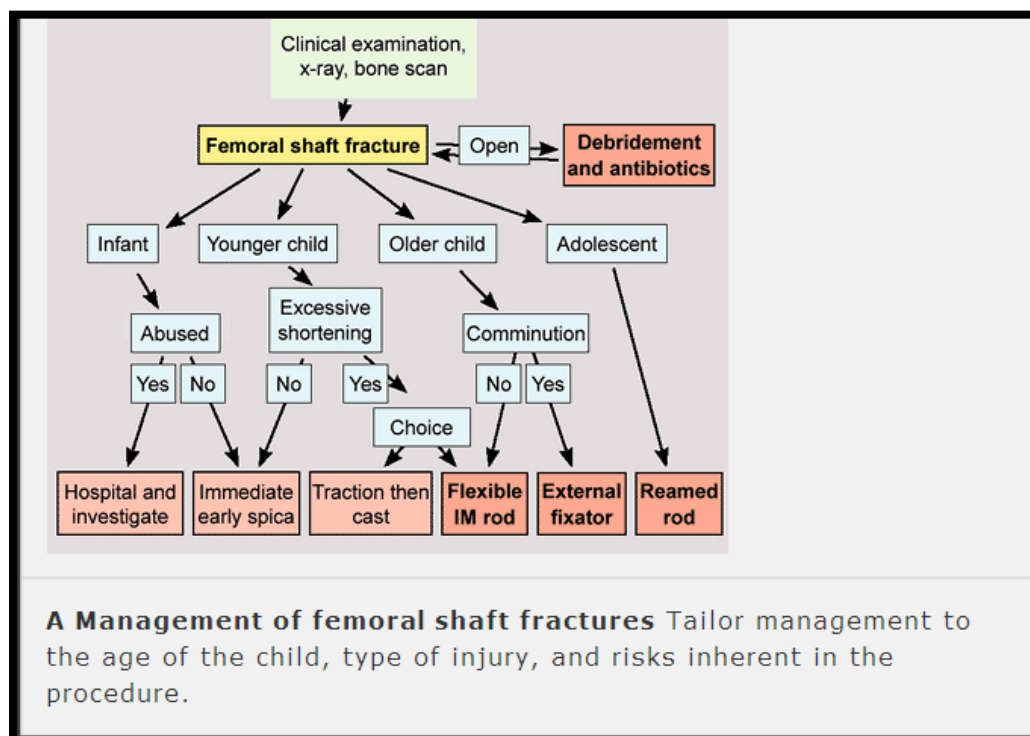
Table 48.1. Acceptable angulation

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

*You don't have to know the numbers

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

1. What are the common fracture pattern in Infants?
 - A. Infants: diaphyseal fractures
 - B. Infants: metaphyseal fractures
 - C. Infants: epiphyseal injuries
2. What are the most important systems you have to check in Clavicle Fracture?
 - A. Neurovascular
 - B. Pulmonary function
 - C. a & b
3. What are the most common type of Clavicle Fracture?
 - A. Type I: Middle third
 - B. Type II: lateral third
 - C. Type III: Medial third
4. What is the cause of Femoral Shaft Fractures In children younger than walking age?
 - A. Child abuse.
 - B. RTA.
 - C. Birth injury.
5. Bicortical injuries should be treated as?
 - a. In a long arm cast.
 - b. Closed reduction followed by percutaneous pinning.
 - c. Reduction.

Answers

1.a 2.c 3.a 4.a 5.a

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