

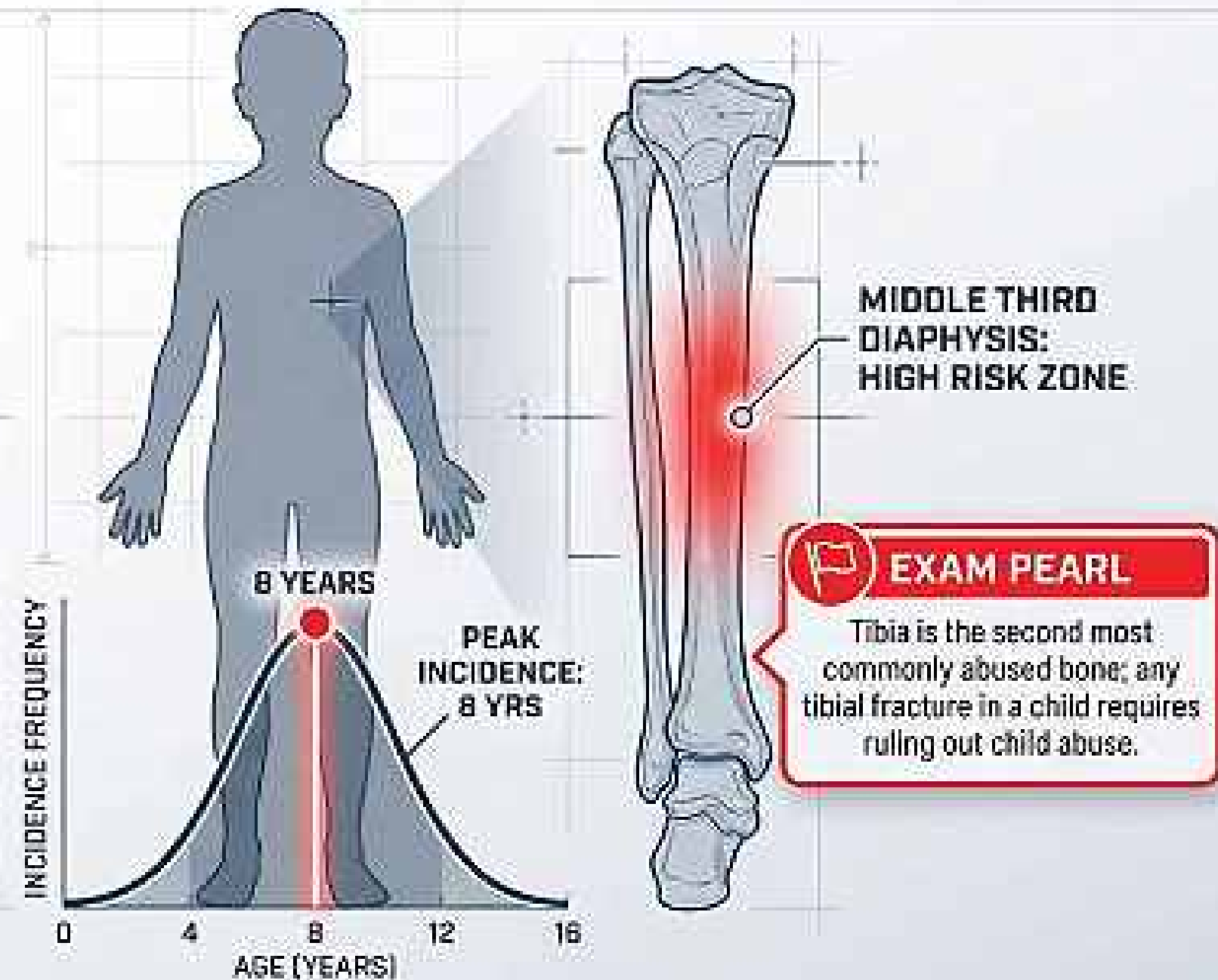


PG Residency Pediatric Tibial Fractures

Smart Notes. Better Scores.



EPIDEMIOLOGY & HIGH-YIELD DEMOGRAPHICS OF PEDIATRIC TIBIAL FRACTURES



EPIDEMIOLOGY

- 3rd most common pediatric long bone fracture (after forearm, femur)
- Accounts for approximately 15% of all pediatric fractures

DEMOGRAPHICS

- 39% occur specifically in the middle third of the diaphysis
- Mean age of occurrence is 8 years; twice as common in males

TRAUMA CONTEXT

- 3rd most common long bone fracture in polytrauma settings
- Isolated fibula fractures are rare; always consider associated mechanisms



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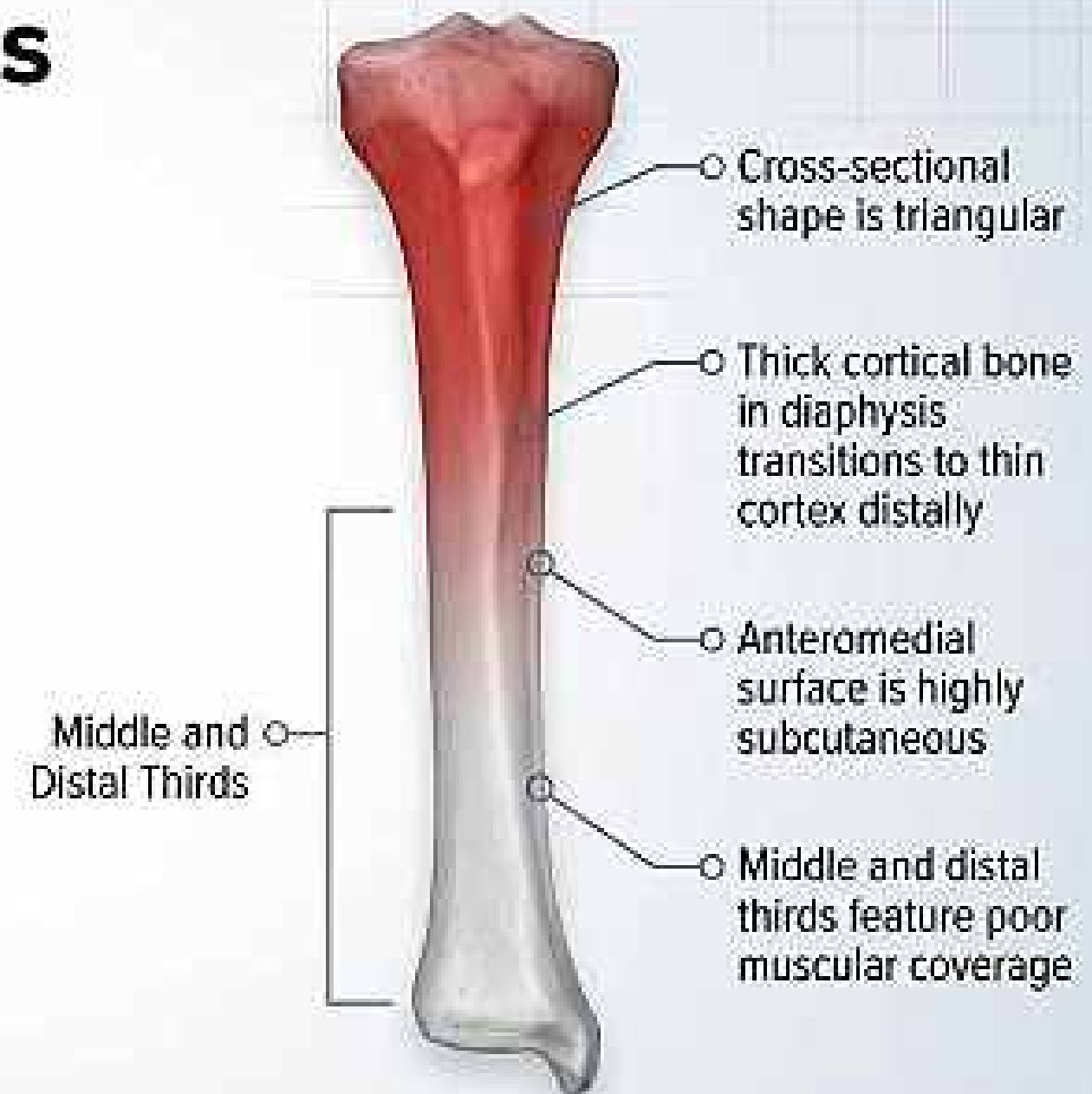
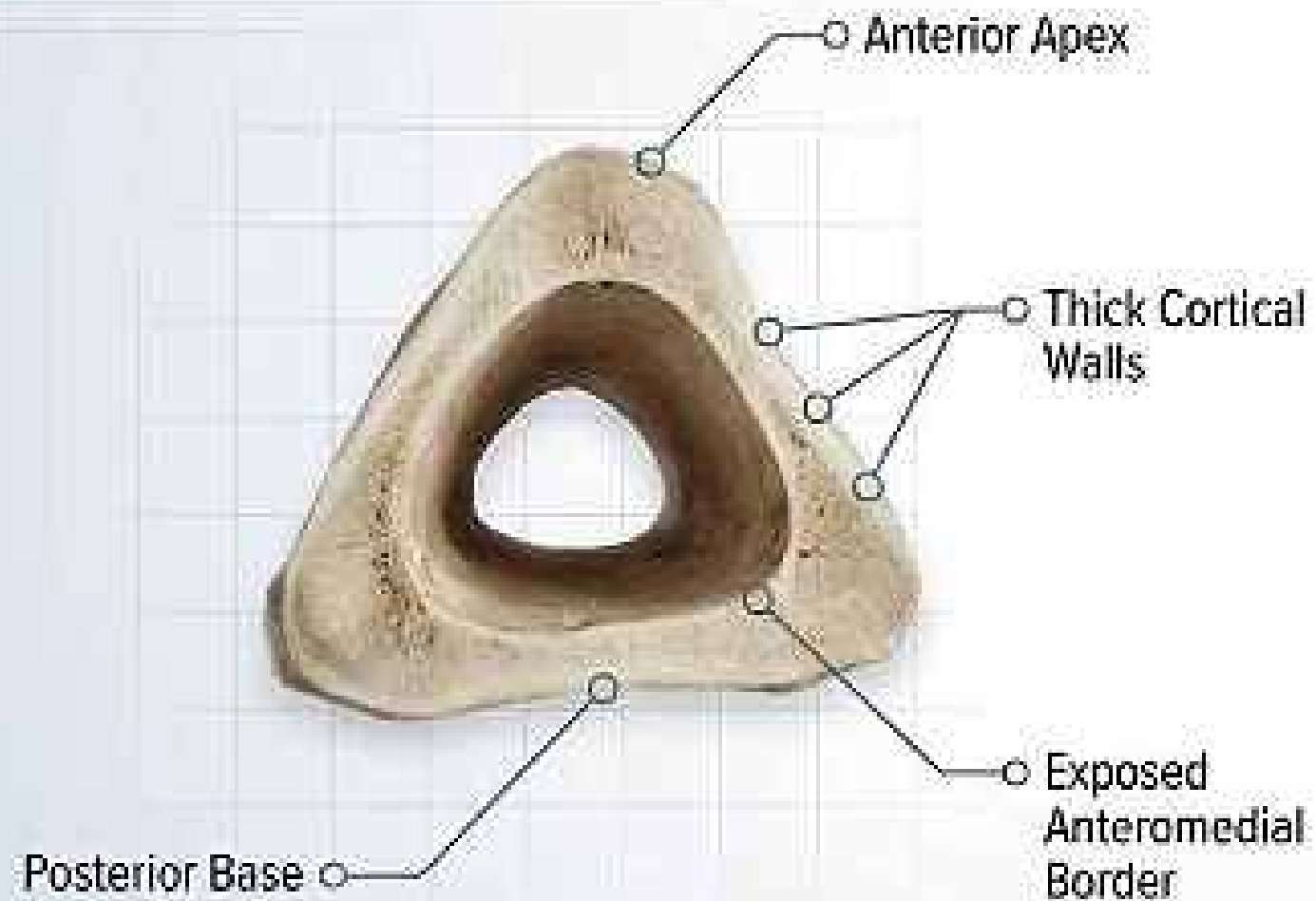
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Osteology, Biomechanics, and Soft Tissue Vulnerabilities



EXAM PEARL: The vulnerability of the middle and distal thirds to delayed union is a direct consequence of their deficient muscular e



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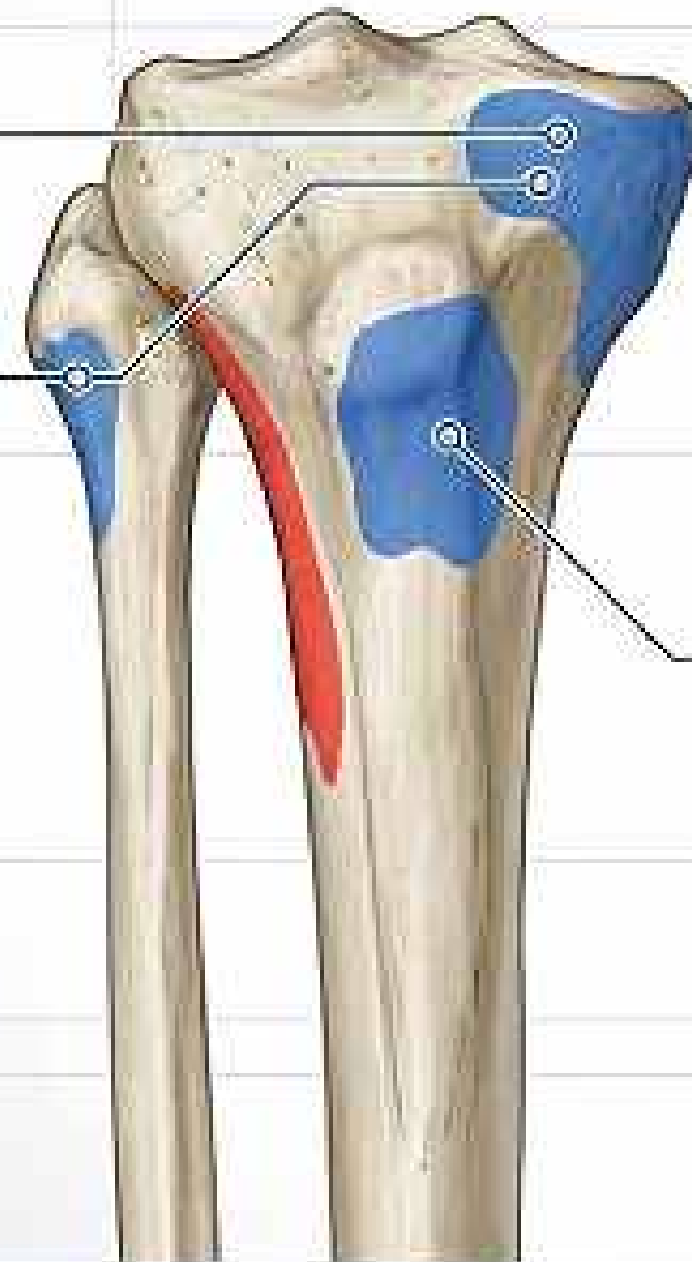
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Key Proximal Muscle Attachments

Medial Insertions (Blue)

- **Semimembranosus:** Inner tuberosity of proximal medial tibia
- **Sartorius, Gracilis, Semitendinosus:** Proximal medial metaphysis

Anterior View



Posterior View



Lateral & Anterior Attachments

- **Tibialis Anterior, EDL, Biceps Femoris:** Lateral tibial condyle
- **Tensor Fascia Lata:** Inserts on Gerdy's tubercle (lateral proximal tibia)
- **Patellar Tendon:** Inserts on the patellar tuberosity

EXAM PEARL

Injury to the proximal tibial physes or the tibial tubercle during treatment or trauma can cause a severe recurvatum deformity.

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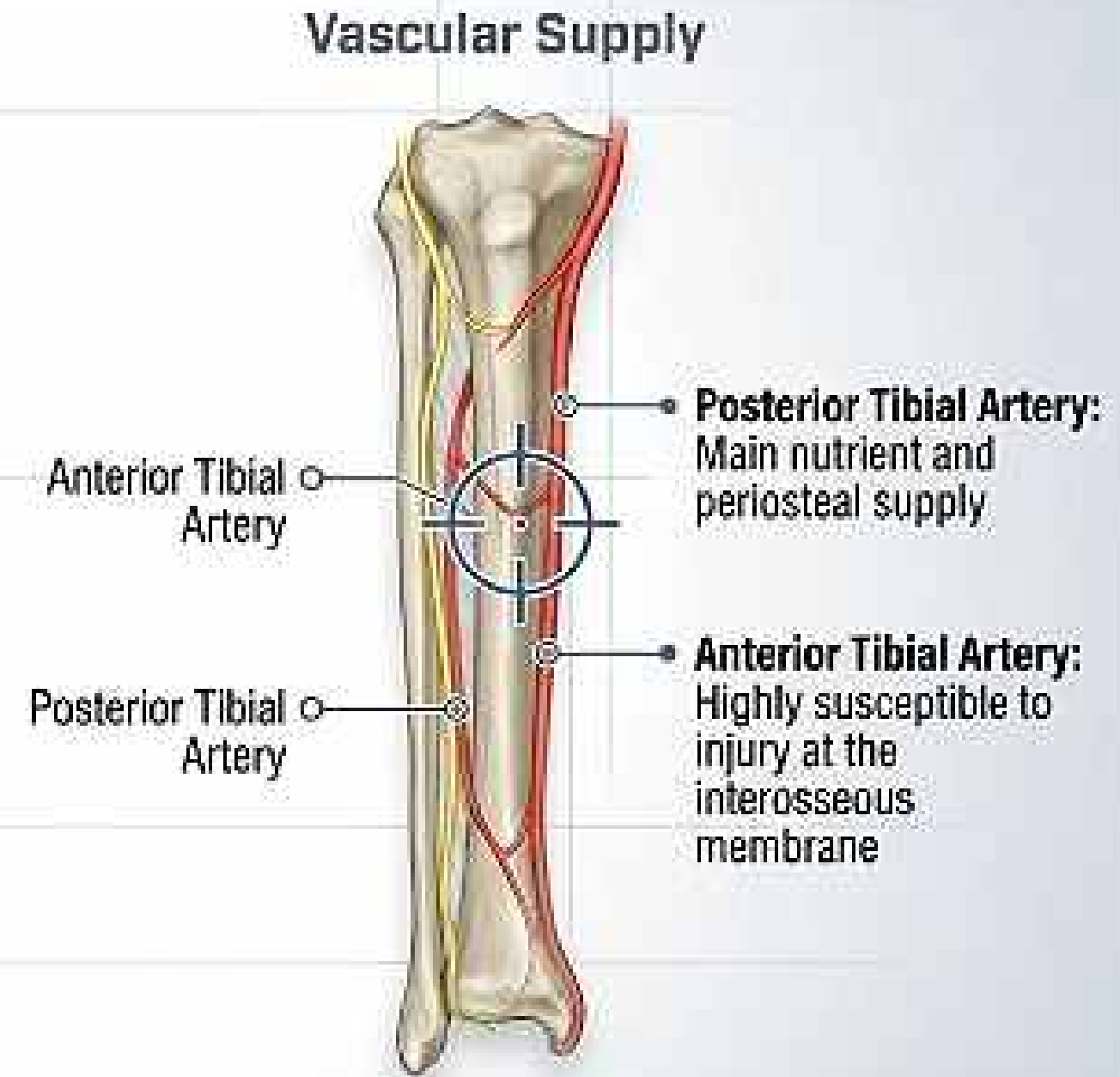
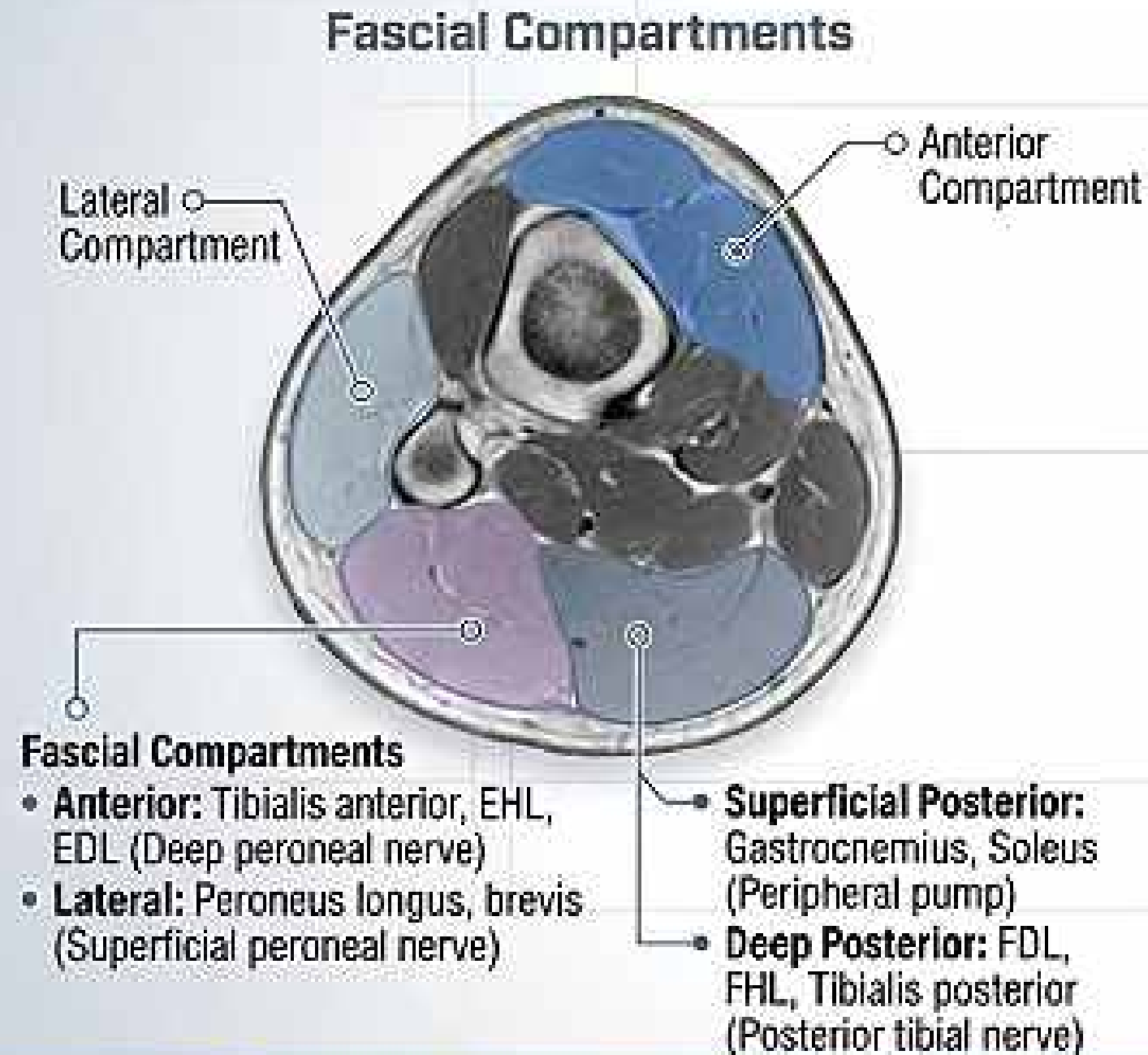


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Compartments, Innervation, and Vascular Supply



EXAM PEARL: The anterior tibial artery is specifically at risk in proximally displaced metaphyseal fractures where the distal fragment translates posteriorly.



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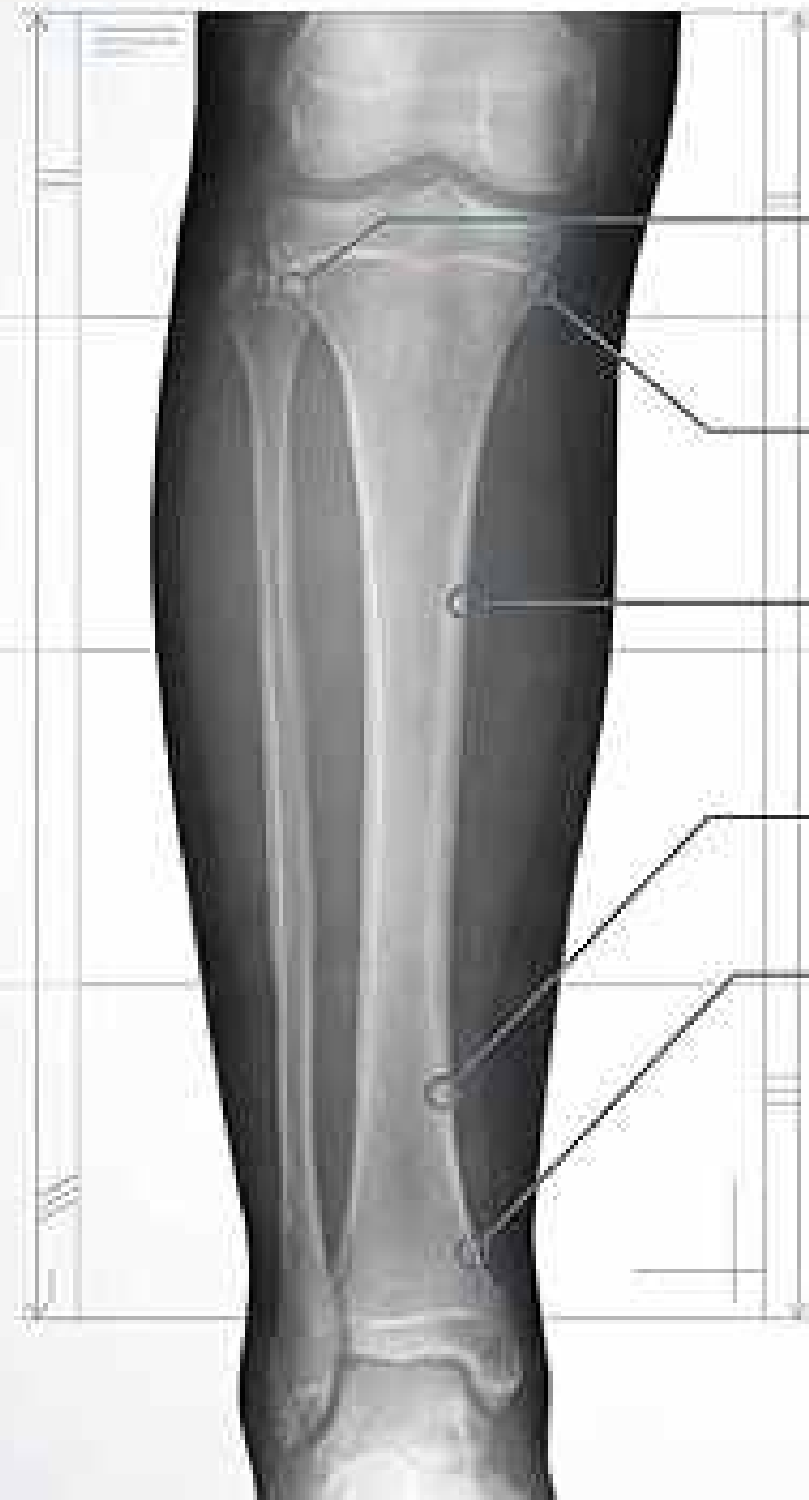
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Ossification Timelines and Weight-Bearing Dynamics

Fibula Biomechanics

- Bears 6–17% of total body weight



- **Proximal fibular physis:** Closes at 15–18 years
- **Proximal tibial physis:** Closes at 14–16 years
- **Tibial diaphysis:** Ossification begins at 7 weeks gestation
- **Distal tibial physis:** Closes at 14–15 years
- **Distal fibular physis:** Closes at approximately 16 years

EXAM PEARL

Do not mistake a physeal scar for a fracture; the scar may remain visible on X-ray long after the physis has functionally closed.

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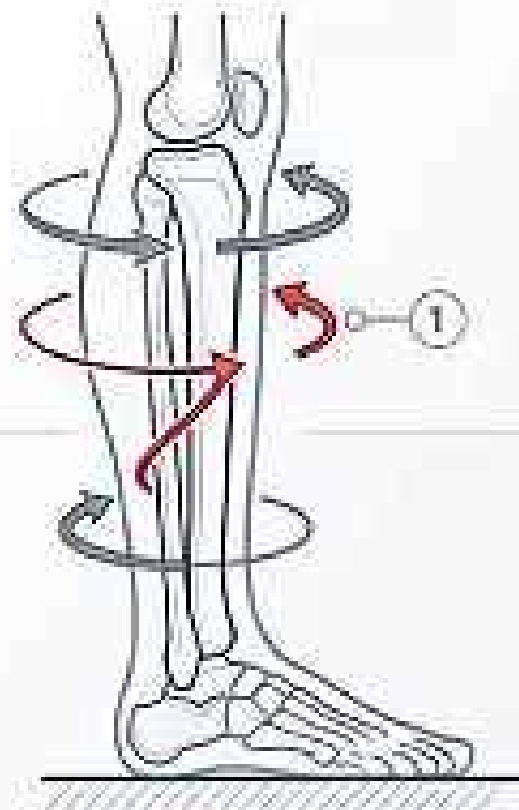
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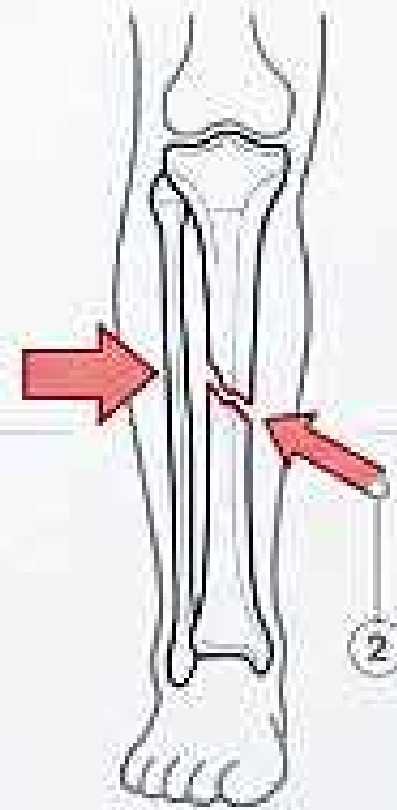
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Fracture Patterns and Deformity Biomechanics

Mechanism of Injury

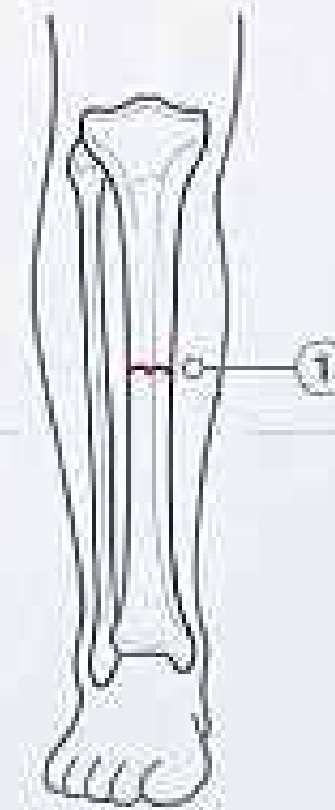


Torsional Force: Body rotates on planted foot, causing oblique/spiral fractures.

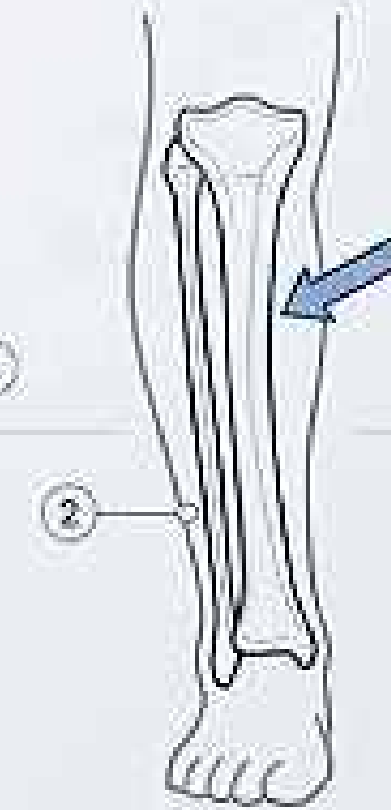


Direct Trauma: Causes isolated transverse or comminuted fractures.

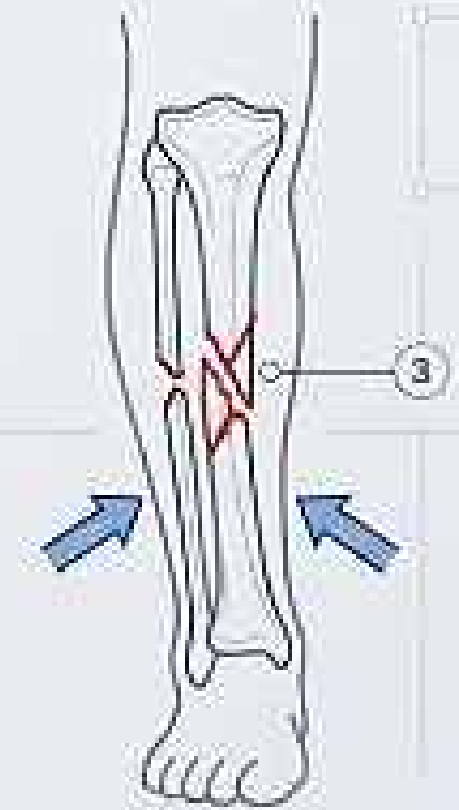
Deformity Prediction



Transverse Tibia + Intact Fibula: Generally stable, minimal displacement.



Intact Tibia Only: Varus deformity (driven by anterior compartment pull).



Comminuted Tibia + Intact Fibula OR Tibia + Fibula Fractured: Valgus deformity (anterior and lateral compartment pull).

EXAM PEARL: An intact fibula frequently drives a varus deformity due to the unopposed pull of the anterior compartment musculature.

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Clinical Assessment, Triage, and Diagnostic Strategy

Initial Clinical Assessment

- Always assume an open fracture until proven otherwise
- Capillary refill must be < 3 seconds
- Immediate neurological impairment is rare
- Monitor toe pain response and pain with passive motion

Plain Radiographs



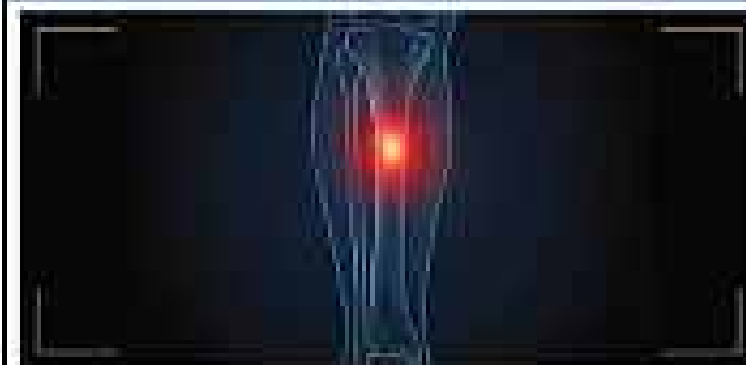
AP and Lateral views must include knee and ankle joints.

CT Scan



Subtle fractures, oblique patterns, intra-articular extension.

Bone Scan



Occult or stress fractures.

MRI



Neoplasms or soft tissue injury.



EXAM PEARL: Pain with passive stretch of the toes is a critical early sign of impending compartment syndrome and must be actively monitored.

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The Toddler's Fracture



EXAM PEARL

An initial negative X-ray does not rule out a Toddler's fracture; treat clinically if the child refuses to weight-bear and has localized tenderness.

Clinical Presentation: Refusal to bear weight + localized tenderness

Imaging: Initial X-rays may appear negative

Diagnosis: Tibial fracture with an intact fibula

Management: Cast for 6 weeks + Repeat XR every 2–3 weeks

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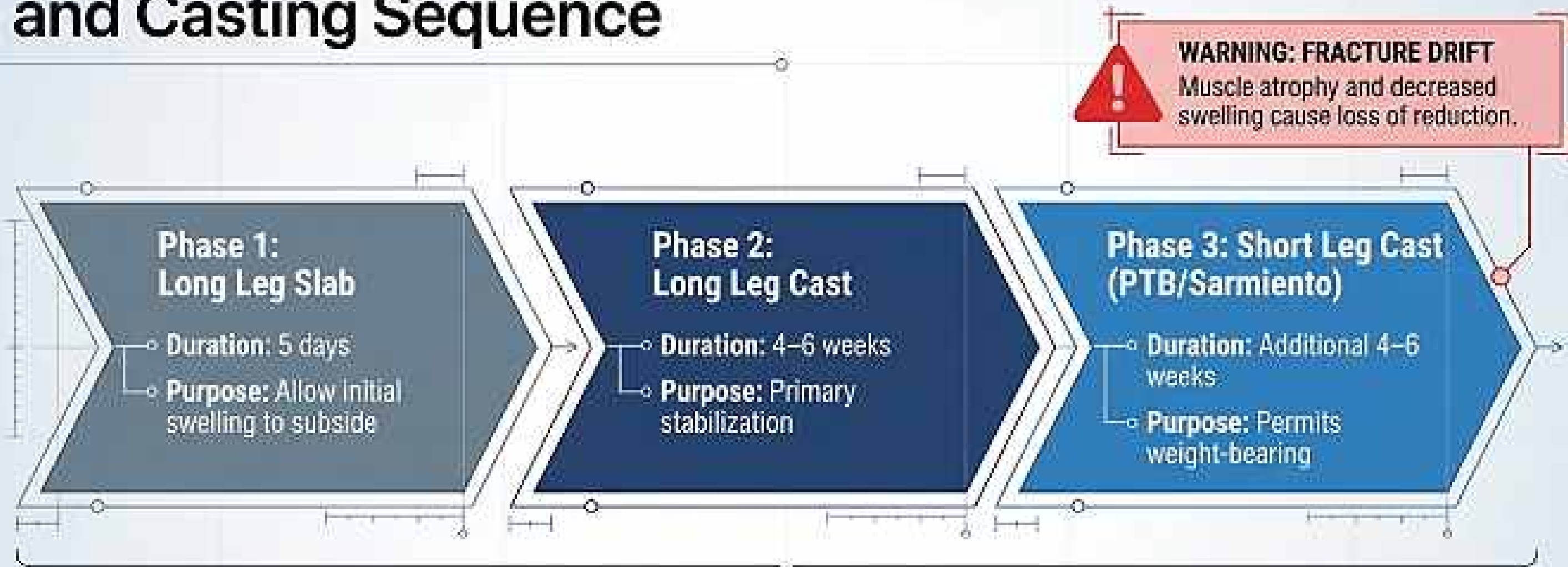
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Non-Operative Management and Casting Sequence



Total duration up to 12 weeks (3 months) in adolescents.



EXAM PEARL: Reduction of soft tissue swelling and muscle atrophy inside the cast predictably leads to fracture drift, necessitating re-manipulation under sedation and a new cast.

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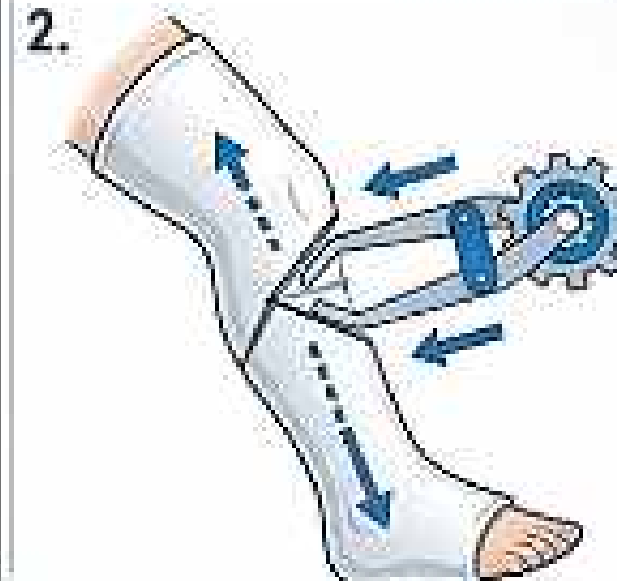
Cast Wedging Technique

Indications:

- Loss of reduction
- Malalignment after initial casting



1. Identify the apex of the fracture and cut the cast on the OPPOSITE side.



2. Spread the cast open to correct alignment and maintain length. (Avoid closed wedging which causes shortening).



3. Insert plastic shims or tongue depressors to maintain opening. Ensure they do not cause skin necrosis.



EXAM PEARL: Always perform an open wedge rather than a closed wedge, and remember the exact ratio: 1 cm of wedging corrects 10 degrees of angular correction.

RULE OF THUMB:
1 cm = 10° of
 of wedging angular correction

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Acceptable Reduction Criteria Thresholds

Strict radiographic parameters must be met to avoid surgical intervention. Criteria tighten significantly for children >8 years due to decreased remodeling potential.

Deformity Parameter	Age < 8 years	Age > 8 years
Valgus Angulation	< 5 degrees	< 5 degrees
Anterior Angulation	< 10 degrees	< 5 degrees
Posterior Angulation	< 5 degrees	< 2 degrees
Shortening	Around 10 mm	Around 4 mm
Rotation	< 5 degrees	< 5 degrees



EXAM PEARL: Rotational deformity does not remodel spontaneously; less than 5 degrees is the absolute maximum accepted at any age.

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Surgical Indications



ABSOLUTE INDICATIONS

- Inability to attain or maintain reduction in cast
- Open fractures
- Severe swelling or acute impending compartment syndrome
- Polytrauma
- Segmental fractures



RELATIVE INDICATIONS

- Significant soft tissue injury
- Floating knee injuries
- Large or obese child



EXAM PEARL: The presence of a floating knee or a severely obese pediatric patient are highly tested relative indications for abandoning non-operative management.

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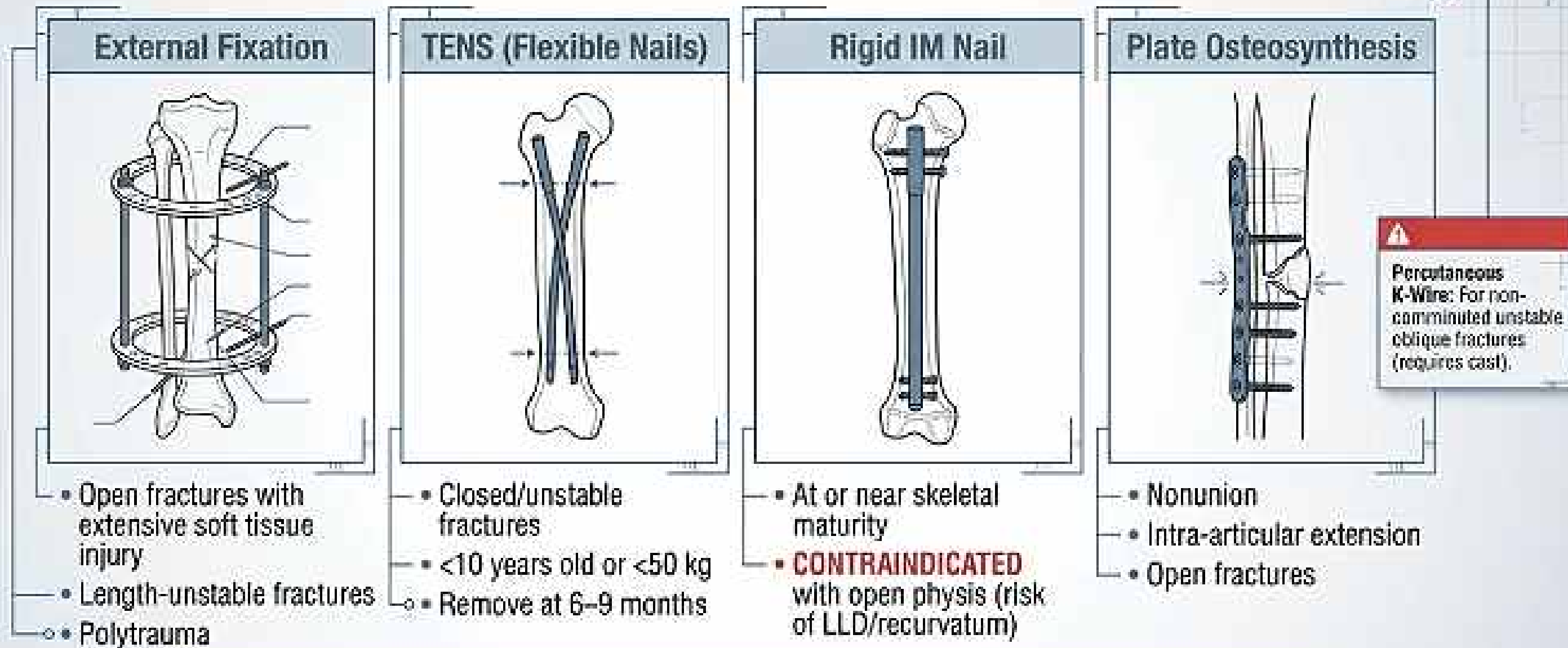
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Specific Operative Fixation Methods



Percutaneous K-Wire: For non-comminuted unstable oblique fractures (requires cast).

EXAM PEARL: Flexible intramedullary nails (TENS) are contraindicated in children >10 years or >50 kg due to a lack of rotational and length stability.

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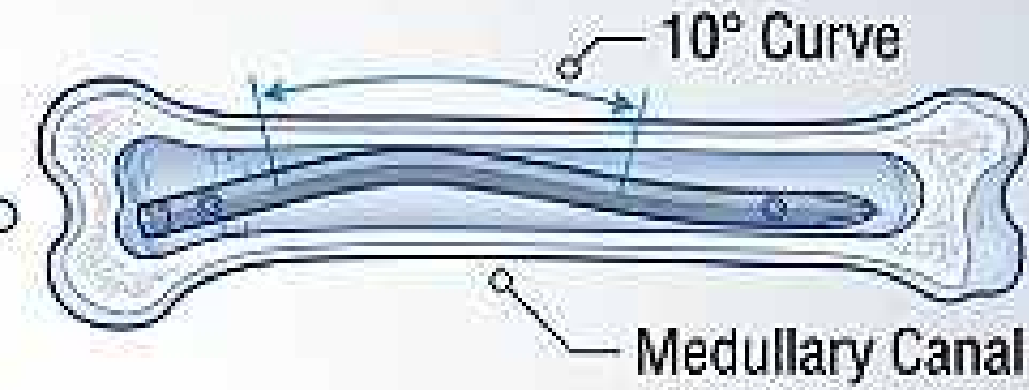


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Surgical Pitfalls and Intraoperative Management

PITFALL	SOLUTION
TENS: Difficulty Passing Nail	Bend nail precisely by 10°, decrease diameter, or curve away from far cortex. 
TENS: Poor Alignment Control	Use thicker nails to increase stability. 
Ex Fix: Early Pin Loosening	Prevent thermal necrosis with constant irrigation during drilling. 
Ex Fix: Pin Tract Infection	Treat with small skin incisions to release tension + regular cleaning. 

EXAM PEARL: Thermal necrosis during drilling is the primary preventable cause of early pin loosening in external fixators.

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Acute Complication: Compartment Syndrome

Clinical Suspicion

- Pain out of proportion requiring increasing analgesia
- Pain on passive stretch (MOST IMPORTANT EARLY INDICATOR)

Initial Cast Management

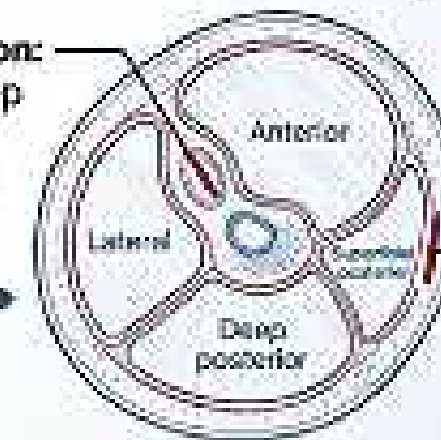
- Bivalve cast
- Split cast
- Remove cast/splint entirely

Surgical Decompression

- Persistent symptoms mandate immediate two-incision fasciotomy

Two-Incision Fasciotomy Approach:

- Medial Incision: Accesses deep posterior compartment



- Lateral Incision: Accesses anterior, lateral, and superficial posterior compartments



EXAM PEARL: Compartment syndrome requires immediate action based on severe pain with passive stretch, long before neurological impairment or pulselessness occurs.

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Late Complications: Nonunion, LLD, and Soft Tissue Coverage

Bone Healing & Alignment Complications

Delayed Union:

Treat with **1 cm Partial Fibulectomy**
(restores axial compression)

Malunion:

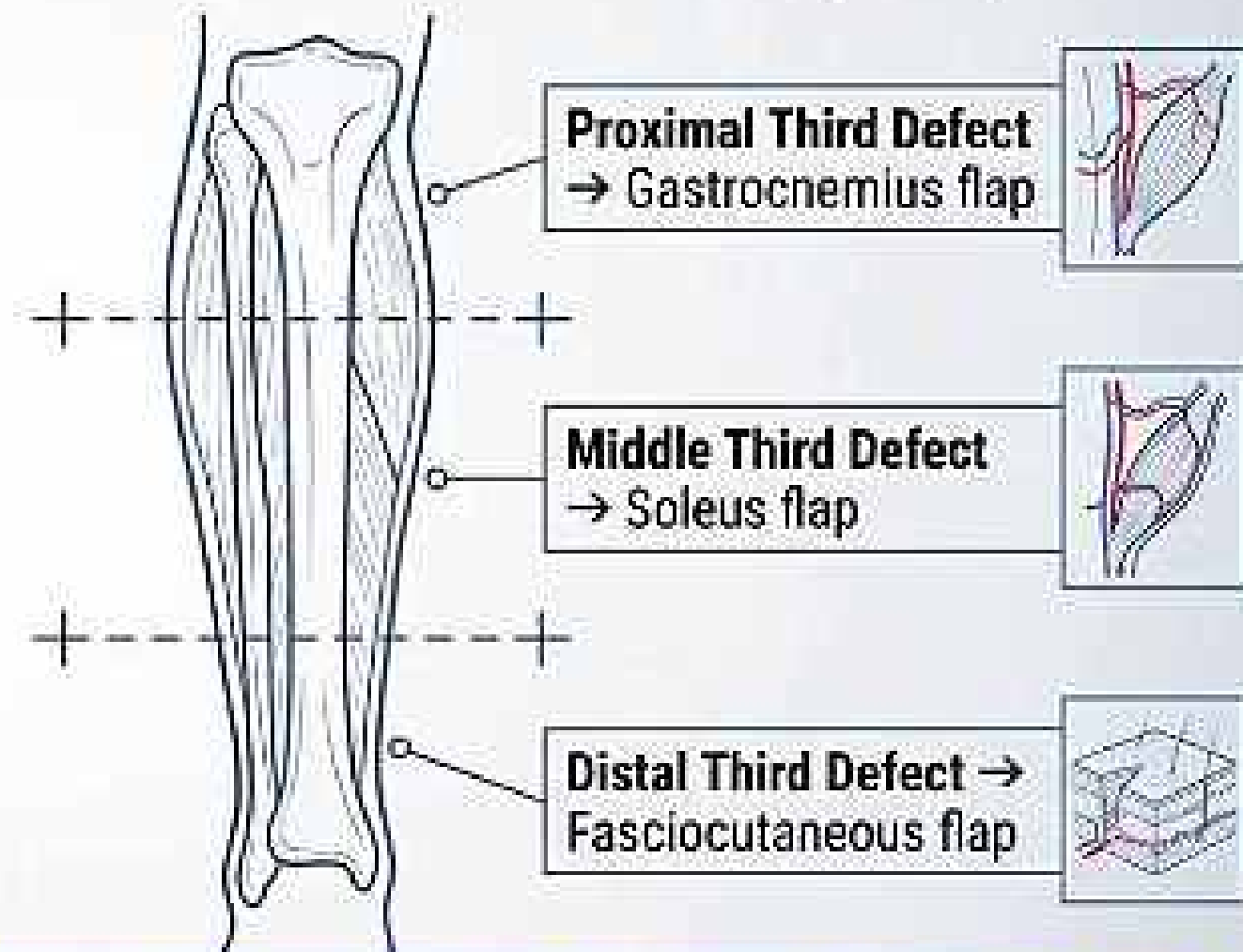
Axial correct spontaneously.

Rotational NEVER corrects
(requires derotation osteotomy)

LLD (Overgrowth):

Due to **physeal stimulation**; less pronounced than in femur

Soft Tissue Coverage Map



EXAM PEARL: Removing exactly 1 cm of the fibula dynamically increases axial compression at the tibial fracture site during weight-bearing, stimulating delayed union healing.



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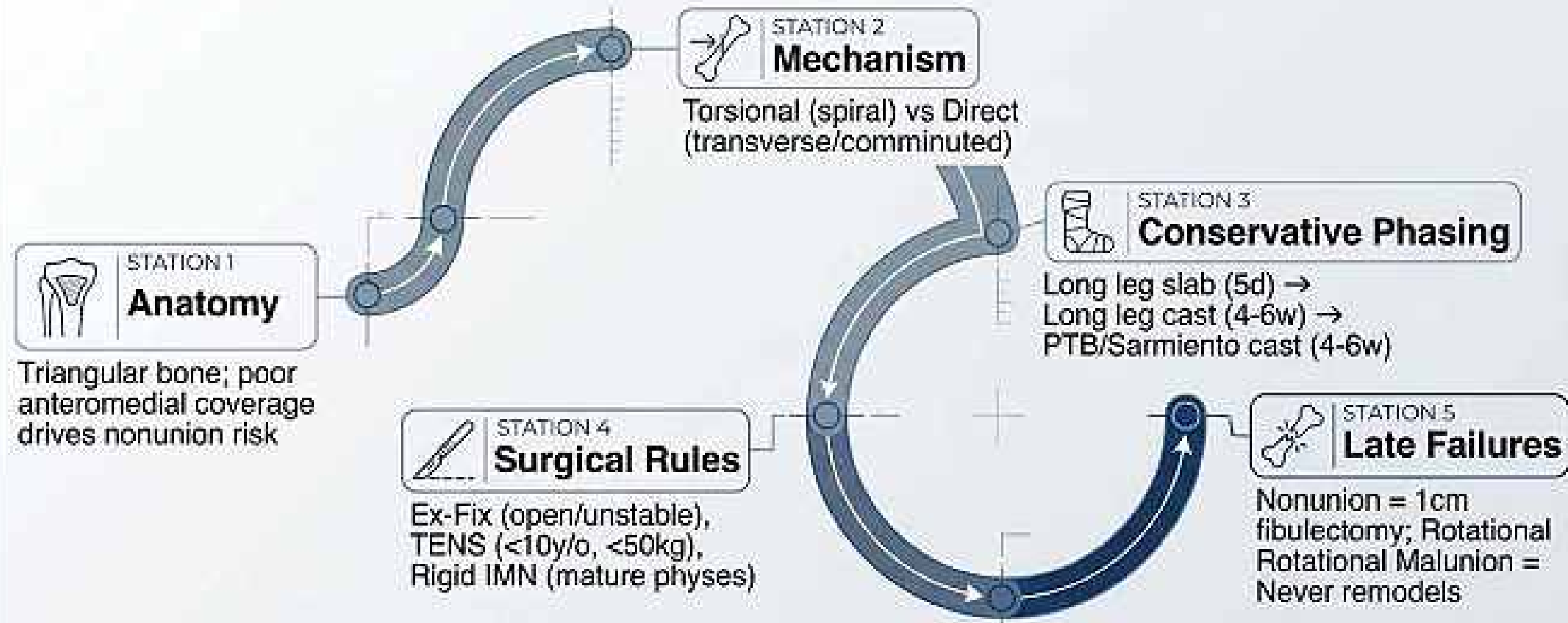
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Rapid Revision Summary Pathway



EXAM PEARL: Age 8 is the critical watershed year defining whether a pediatric tibia will remodel adequately or require highly rigid anatomic alignment.

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Must-Remember Values and Common Exam Traps

CLINICAL TRAPS

- **TRAP:** Assuming an initial negative X-ray rules out a **Toddler's fracture**.
- **TRAP:** Attempting **closed cast wedging** (causes shortening and skin necrosis).
- **TRAP:** Ignoring **toe stretch pain** because distal pulses are normal.

GOLDEN EXAM VALUES

- **Cast Wedging Ratio:** **1 cm** wedge gives exactly **10°** of correction.
- **Fibula Load:** Bears **6–17%** of total body weight.
- **Nonunion Surgery:** Resect exactly **1 cm** of fibula.

FINAL TAKE-HOME MESSAGE

Rotational deformity (<5° maximum tolerance) will NEVER remodel spontaneously. Failure to adhere to this rule invariably necessitates a surgical derotation osteotomy.



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