Pediatric Femoral Shaft Fractures
Presented by members of POSNA
Resident Comprehensive Fracture Course

Treatment Varies with Age...

Basic Treatment Guidelines

- 0-6 m
- 6 m-5 yr
- 5-11 yr
- > 11 yr

- Pavlik Harness
- Spica Cast
- Flexible IM Nails
- Rigid IM Nail

...but age isn’t the only factor to consider

IM Fixation is Far From the Only Fixation Option

- Open Plating
- External Fixation
- Submuscular Plating

How Much Do We Really Know?

Clinical Practice Guidelines

AAOS Clinical Practice Guidelines

- Questions:
  - What are the advantages of surgical stabilization over casting?
  - Is one form of surgical stabilization superior to another?
  - Which treatments have the best evidence to support their use?

AAOS Clinical Practice Guidelines

<table>
<thead>
<tr>
<th>Age</th>
<th>Recommendation</th>
<th>Evidence</th>
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<tbody>
<tr>
<td>&lt; 36 Mos</td>
<td>Evaluate for Abuse</td>
<td>Good</td>
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<tr>
<td>≤ 6 Mos</td>
<td>Spica Cast and Pavlik are Treatment Options</td>
<td>Poor</td>
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<tr>
<td>6 Mos–5 Yrs</td>
<td>Immediate or Delayed Spica Casting if &lt; 2cm Shortening</td>
<td>Good</td>
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<tr>
<td>5-11 Yrs</td>
<td>Flexible Nails are a Treatment Option</td>
<td>Poor</td>
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<tr>
<td>&gt; 11 Yrs</td>
<td>Trochanteric Nails, Submuscular Plates and Flexible Nails are Treatment Options</td>
<td>Poor</td>
</tr>
</tbody>
</table>

AAOS. "Treatment of pediatric diaphyseal fractures: guideline and evidence report." 2009
Does This Help?

Unable to Recommend For Or Against…

- Removal of Hardware
- Physical Therapy
- Using Weight as a Treatment Criterion
- Using Any Amount of Rotation or Angulation as a Criterion for Altering Treatment

AAOS. “Treatment of pediatric diaphyseal fractures: guideline and evidence report.” 2009

19 month old: Fall From Bed

History of Femur Fracture During Delivery Treated in Pavlik Harness

I want to…

A. Put the kid back in a Pavlik Harness. It worked the first time.
B. Reduce the fracture to it pre-fracture alignment and apply a spica cast. She’ll remodel that femoral bow with time.
C. Reduce the fracture to anatomic alignment and apply a spica cast.
D. Do a femoral osteotomy to correct the deformity and fix it with flexible nails.
E. Do a femoral osteotomy and plate it. It’ll be tricky passing nails as the intramedullary canal may be occluded due to the prior fracture

Spica Applied

FRACTURE REDUCED TO PRE-FRACTURE ALIGNMENT

6 Weeks Later….

What’s Your Plan?

6 Weeks Later….

SPICA REMOVED
3 Months Later: Fall from a Standing Height

3 Months Later: Fall from a Standing Height

SPICA REMOVED

I want to...

A. Accept the deformity and put the kid back in spica… but keep it on longer this time.
A. Reduce the fracture to anatomic alignment and apply a new spica cast.
A. Accept the deformity and place flexible IM nails. The nails will prevent re-fracture while she remodels the deformity.
A. Do a femoral osteotomy to correct the deformity and fix it with flexible nails.
A. Do a femoral osteotomy and plate it. It’ll be tricky passing nails as the intramedullary canal may be occluded due to the prior fracture.

Spica Applied with Femur in Anatomic Alignment

6 Weeks Later….

Spica Applied with Femur in Anatomic Alignment

6 Weeks Later….

Spica Casting

- Immediate Casting
- Traction + Delayed Casting
- Supplement to Internal Fixation

Contraindications:
- Polytrauma
- Skin Issues
- Shortening > 2.5 cm (relative)
- Altered sensation (relative)

Alternative Treatments:
- Flexible IM Nails
- External Fixation
- Plate and Screws

6 Year Old: Fell from Scooter

6 Year Old: Fell from Scooter
I would treat this with…

A. A Spica Cast: The parents will hate it but it will spare the kid a surgery.
B. A Submuscular Plate: It’ll have to be long but I don’t think flexible nails will maintain proper length with this long spiral fracture pattern.
C. Flexible Nails: That’s the book answer for a 6 year old right?
D. A Rigid Trochanteric Entry Nail: It has all the benefits of flexible nails but I can lock it distally to maintain length!
E. An External Fixator: It hasn’t been mentioned as an option for any questions so far. Since it’s an option here it’s probably the right answer.

Flexible IM Nails

1 Week Post-Op 12 Weeks Post-Op

Flexible Intramedullary Nails

Ideal Patient:
- Age 5 - 11 Years
- Weight < 50 kg
- Mid-Shaft Fracture

Actual Practice:
- Ages 2 – 14 years
- Any Fracture Location
- All Fracture Patterns

Length Unstable FXS: Consider Locking
- Various Nail Materials and Constructs

External Fixation

Used Less Frequently
- Indications:
  - Open Fractures
  - Multiply Injured Patient?
  - Floating Knee?
  - Severe Comminution?
- Downsides:
  - High Re-Fracture Rate
  - Pin Site Infection
  - Delayed Union

8+3 y.o. male got knocked down by his bulldog; Inability to bear weight through right leg

I’d Fix This With…

A. Retrograde Flexible Nails
B. Anterograde Flexible Nails
C. Submuscular Plating
D. Open Plating
E. External Fixation
Post Op Films

Another Option?

2 weeks post op

6 months post op

7 months post op

Open Plating

- AO Principles
- Good Option For:
  - Proximal Fractures
  - Some Open Fractures
- Downsides:
  - Extensive Dissection
  - Blood Loss
  - Plate Removal
  - Stress Risers
3 year old: Motor Vehicle Collision

What Else Do We need to Know About?

Associated Injuries:
- Right Femur
- Left Hip
- Right Ankle
- Left Wrist
- C-Spine

How Should We Treat the Right Femur?
- A. Spica Cast
- B. Skeletal Traction
- C. Flexible Nails
- D. External Fixation
- E. Open or Submuscular Plating

Traction Film:

Does this change your plan?

ORIF Femur:
- 3.5 LCDC Plate

...and treat everything else.

Sub-Muscular Plating
- Increasingly Popular
- Good Option For:
  - Comminuted Fracture
  - Distal Fractures
- Downsides:
  - Learning Curve
  - Stress Risers
  - Plate Removal
  - Valgus Deformity?
Rigid IM Nailing

- Typical Indications:
  - Older Patients: Age > 11 yrs
  - Large / Heavy Children
  - Comminuted Fractures

- Use Trochanteric Entry Nail
  - Piriformis Nail = Risk of AVN
  - Violates Ascending Cervical Artery

- Beware Rotational Malalignment

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I want to...

A. Take a closer look…. something seems funny about this fracture
B. Treat this with traction until it gets sticky then a single leg spica cast. That fracture is awfully high and he might need a supplemental cast even if I fix it.
C. Treat this with a submuscular plate. Locking plate technology is cool!
D. Treat this with flexible nails.
E. Transfer this to an adult trauma center. Subtrochanteric fractures are hard… let the adult guys do it.

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Take a closer look....

CT Scan: Lytic Lesion

Differential Diagnosis?
What’s Your Plan?

A. Spica Casting. I might do more harm than good putting hardware into pathologic bone.
B. Retrograde Flexible IM Nailing. This is a thin 10 year old…perfect indication.
C. Open Biopsy and Flexible Nailing. I want to know what this is while my flexible nails are holding perfect alignment.
D. Rigid IM Nailing. The fracture seems a little high for flexible nails.
E. Open Biopsy and Flexible Nailing. Not every lytic lesion is a Unicameral Bone Cyst….

Open Biopsy and Rigid IM Fixation

Lesion: Firm Pink-Tan Rubbery Tissue
Path: Fibrous Dysplasia

COMPLICATIONS

Delayed Union / Non-Union (Rare)
Limb Length Difference
Malunion / Deformity
Re-fracture

Limb Length Discrepancy

- 7-10 mm Overgrowth Expected (children < 10 yrs)
- Excessive Overgrowth Possible
- Excessive Shortening Possible (Spica)
- Inform Family Prior to Treatment

Refracture

- Load-Bearing Devices:
  - Plates
  - External Fixators
- External Fixators:
  - Through healed fracture site After Removal
  - Through pin hole site After Removal
- Plates:
  - In-Situ: Fracture at End of Plate
  - S/P Removal: Fracture Through Screw Hole
13 yo (95 kg) Developmentally Delayed:  
Fell at Home

Lots of Options Right?

Submuscular Plating

4.5 LCDC Plate

But then this happened…

What’s your plan now?

A. Let it heal where it is. He’s fat and the deformity won’t be that noticeable.
B. Manually unbend the plate in the OR and apply a supplemental spica cast….the fixation is good so a straighter plate means a straighter femur
C. Put on a new plate. Do they make something bigger than 4.5?
D. Rigid IM Nailing. Still can’t believe they didn’t do this the first time….
E. External fixation. This has to be the right answer at some point!

Apply Circular Ex-Fix

Remove Plate
**Use Frame to Correct Alignment**

Varus → Valgus

**Malunion**

- Commonly Varus and Procurvatum
  - Preventable
  - Spica Cast Valgus Mold
  - Appropriate Implant and Construct
- Rotational Malunion
  - More Common with Transverse Fractures
  - More Common in Older Children
- Distal Femur Valgus Deformity
  - Associated with IM Plating
  - Distal Fractures
  - Tethering of Lateral Periosteum?
  - Physis Injury During Insertion?

**Other Problems**

- Delayed Union / Non-Union:
  - Open Fractures
  - Load Bearing Implants

- Hardware Problems:
  - IT Band Irritation from Prominent Nails
  - May Result in Painful Knee ROM / Stiffness
  - Can Occur with Distal Plates as Well

**QUESTIONS?**