Treatment and Complications of Fracture Shaft of Femur in Children

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Abstract

Background: The femur is the longest and strongest bone in the body and it is almost cylindrical in the major part of its extent. The femur, as other long bones, is divided to a body, upper and lower extremities**.** Pediatric femoral shaft fractures are the most common orthopaedic injury treated by orthopaedic surgeons. They also represent the most common pediatric orthopaedic injury requiring hospitalization. The mechanism of injury of the fracture differs with age due to the increasing thickness of cortical shaft with skeletal growth and maturity. Fracture femur could be the result of high or low energy trauma. The fracture shaft of femur in children can be treated by many methods depending on age of child.

Keywords: Fracture Shaft of Femur, Children

Introduction:

The femur is the longest and strongest bone in the body and it is almost cylindrical in the major part of its extent. The femur, as other long bones, is divided to a body, upper and lower extremities. **(1)**

Pediatric femoral shaft fractures are the most common orthopaedic injury treated by orthopaedic surgeons. They also represent the most common pediatric orthopaedic injury requiring hospitalization. It occurs more commonly in boys than girls with a ratio of 2.6:1. **(2)**

A bimodal distribution pattern defines the incidence by age, with a peak during toddler years from simple falls and low energy trauma; and again in early adolescence from high velocity injuries. Stress fractures can occur in any location in the femoral shaft. In this era of high intensity, year-round youth sports, orthopaedists are encountering more adolescents with femoral stress fractures**.(3)**

Mechanism of injury:

The mechanism of injury of the fracture differs with age due to the increasing thickness of cortical shaft with skeletal growth and maturity. Fracture femur could be the result of high or low energy trauma. **(2)**

The child abuse was the most common cause of lower extremity fractures in children younger than 18 months; it accounts 67% of cases **(4)**

Young children could sustain fracture femur from falling to the ground or injury by blunt heavy object.**(2)** With older children the cortical bone thickness increases and it becomes more resistant to torque or bending and compressive forces. In adolescents motor vehicle collisions

and road traffic accidents account for the majority (about 90%) of fracture femur in this age group.**(5)**

Pathological femoral fractures are relatively rare in children, but may occur because of generalized osteopenia in infants or young children with Osteogenesis Imperfecta and conditions as cerebral palsy, myelomeningocele, bone tumors.**(6)**

Evaluation of pediatric femoral fractures relies in most of the cases on clinical examination and plain radiographs in AP and lateral views. Clinically the patient presents with a clear history of trauma, swelling, deformity (shortening, external rotation), inability to walk, edema and ecchymosis. Upon examination, the above presentation is confirmed and a thorough examination for other serious injuries is conducted**.(7)**

The fracture shaft of femur in children can be treated by many methods depending on age of child.

Table (1): Summary of suitable treatment options available for management of pediatric shaft femur fractures according to age of the child. **(8)**

Age of child	Preferred management	Other modalities
0-6 months	Pavlik harness	Hip spica
6 months to 2 years	Hip spica	Traction followed by spica
3-5 years	Hip spica	Traction followed by spica/orthosis External fixation Flexible intramedullary nails (Rare)
6-11years	Flexible intramedullary nails	Traction followed by spica External fixation Submuscular plating
More than 12 years	Rigid intramedullary nails (Trochanteric entry)	Flexible intramedullary nails External fixation Submuscular plating

Commonly used methods are:

A. Conservative methods:

- Skin or skeletal traction.
- Immediate hip spica.
- Traction followed by spica. **(9)**

Immediate application of a spica cast, or traction followed by a cast, remains the standard management for most of femoral fractures in children younger than six years of age **(10)**

Figure (1) Thomas splint skin traction (right) **and** Unilateral spica cast (left)[**(11)**

Complications of Spica casting

Complications of Spica casting include edema, vascular compromise , compartment syndrome , skin irritation, poor hygiene, muscle wasting and weakness.**(12)**

B. Surgical methods:

- External fixation.
- Open reduction and internal fixation.
- Intramedullary nailing. **(11)**

Due to advantages of surgical treatment as early mobilization and decreased period of hospitalization, the popularity of surgical treatment is largely increased. **(11)**

1. External Fixation:

External fixator is used as a part of damage controlled orthopedics "DCO" in Polytrauma patients, Gustilo type III C open fractures, prolonged vascular deficit, salvage after major complications following internal fixation and unavailability of other options. **(8)**

- **Advantage:**

It is an excellent method for restoring the length of the limb and achieving satisfactory alignment without long incisions, exposure of the fracture site, major blood loss, or the risk of physeal injury or osteonecrosis. **(8)**

Also, external fixation proposes advantages of minimal surgical dissection, excellent access for wound care with soft tissue injuries, decreased need for a second anesthetic for hardware removal. **(8)**

Disadvantage:

1- Pin tract irritation or infection is common and occurs in about 45% of cases. **(13)**

2- Loss of reduction: in several cases, external fixation requires manipulation and an extra method of fixation to allow better control of fracture.**(14)**

3- Loss of motion: Percutaneous release of iliotibial band anterior to the distal pins is done to allow more excursion to prevent loss of knee motion. **(15)**

4- Malrotation**:** found an average of 10° of rotation in almost 66% of patients. **(15)**

5- Refracture**:** secondary fractures in the femur treated with external fixation.**(13)**

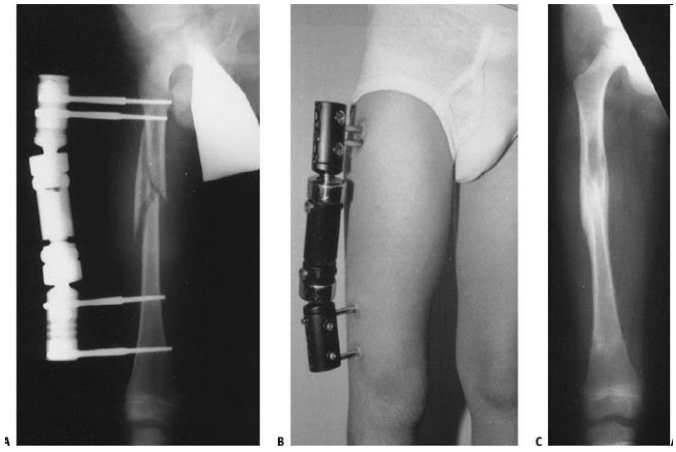

Figure (2) Pre and post operative external fixation of comminuted mid shaft femur fracture **(15)**

2. Open Reduction and Plate Fixation

Plate fixation is an effective treatment for pediatric femoral fractures. Advantages include the familiarity of the technique and widely available equipment as well as rigid fixation in anatomic alignment that allows rapid mobilization. Specific technical recommendations include the use of 4.5-mm dynamic compression plates, with fixation of at least six cortices on each side of the fracture. **(16)**

- **Indications:**

Multiple injuries in a child less than twelve years old and a child needing concomitant repair of the femoral artery. Some surgeons use plates for very proximal or distal fractures, for which there is no other treatment that would allow rapid mobilization. **(16)**

- **Advantage**

Compression plating of diaphyseal femur fractures in children allows stable, anatomic fracture alignment and easier patient mobilization. Less radiation and less demanding. **(16)**

- **Disadvantage**

Exposure of fracture zone increases risk of interference with the healing process, the large incision, greater blood loss, refractures, hardware failure, and issues regarding hardware removal. **(16)**

3. Elastic Intramedullary Nailing:

It is popular, less invasive technique for treatment of fracture shaft of femur in children with low risk of complication and short period of hospitalization**.(17)**

Indication of elastic nails:

Elastic nails can be used in children aged 5 to 14 years with fracture shaft of femur if the fracture was:

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- Transverse fracture.
- Short oblique fracture.
- Poly-trauma patient.
- Concomitant head injury.
- In cases with minimal Comminution.
- Open fracture of type I and II. (18)

Contraindications of elastic nails:

Elastic nails cannot be used in the following cases:

- Long spiral fractures.
- Highly comminuted fractures.
- Patients with over weight.**(18)**

Advantages of elastic intramedullary nails:

1. Minimally invasive technique.
2. Can be done by closed reduction (no need to open fracture site).
3. Can be used in open fracture type I and type II.
4. Acts as internal load sharing splint.
5. No risk of physis injury.
6. Early mobilization and early weight bearing.
7. Short time of hospitalization.
8. Low risk of complication and blood loss. **(11)**

Disadvantages of elastic intramedullary nails:

1. Possibility of pull out of the nail.
2. Second operation for nail removal was needed.
3. In case of premature nail removal, there is a risk of refracture.
4. It is not stable fixation in case of long spiral and highly comminuted fractures and if the child weight more than 45 kg
5. Cannot be used in very proximal or very distal fractures.
6. It can be complicated by knee pain if the nail ends were prominent which lead to early removal of the nail. **(11)**

Figure (3) Elastic Intramedullary Nails **(11)**

Complications of femoral shaft fractures:

1. Leg Length Discrepancy (LLD):

Leg length discrepancy is the most common complication. The fractured femur may be initially short from overriding of the fragments at union; growth acceleration occurs to compensate the difference, but often this acceleration continues and overgrowth occurs **(19).**

a) Shortening:

Because the average overgrowth after femoral fracture is approximately 1.5 cm, a shortening of 2 to 3 cm in the cast is the maximal acceptable amount. The maximal acceptable shortening depends on the age of the child; for example, in a 6- year-old child 2.5 cm may be acceptable, whereas only 1 to 2 cm should be accepted in a 14-year-old approaching skeletal maturity **(19).**

b) Overgrowth:

Overgrowth after femoral fracture is common in children 2 to 10 years of age. The average overgrowth is 0.9 cm, with a range of 0.4 to 2.5 cm **(20).**

2. Angular deformity:

Some degree of angular deformity is frequent after femoral shaft fractures in children, but this usually remodels with growth and it depends on the age of the patient, In infants the acceptable varus angulation is 10 to 15 degrees and acceptable valgus angulation is 20to 30 degrees and 15 to 20 degrees in older children. 74% of the remodeling that occurs is physeal, and appositional remodeling to a lesser degree. Angular remodeling occurs best in the direction of motion at the adjacent joint **(20).**

3. Rotational Deformity:

Rotational deformities of 10 degrees to more than 30 degrees occur in one-third of children after conservative treatment of femoral shaft fractures. The torsional deformity usually is expressed as increased femoral anteversion on the fractured side compared with the opposite side, a difference of more than 10 degrees has been the criteria of significant deformity **(20).**

4. Delayed Union:

Delayed union of femoral shaft fractures is uncommon in children. The time of fracture union is age-dependent. In children under 5 years of age, healing usually occurs in 4 to 6 weeks. In children 5 to 10 years of age, fracture healing is somewhat slower, requiring 8 to 10 weeks. By the age of 15 years, the mean time to healing is about 13 weeks, with a range from 10 to 15 weeks **(19).**

5. Nonunion:

Non-unions of pediatric femoral fractures are rare. Risk factors are adolescents, infections, fractures with segmental bone loss or severe soft tissue loss. Femoral fractures account for only 15% of non-unions in children. Even in segmental fractures with bone loss, young children may have sufficient osteogenic potential to fill in a significant fracture gap **(19).**

6. Muscle Weakness:

Weakness after femoral fracture is noticed in the hip abductor musculature, quadriceps, and hamstrings, but persistent weakness in some or all of these muscle groups is rare. Injury to the quadriceps muscle probably occurs at the time of fracture. Severe scarring and contracture of the quadriceps occasionally results in clinical problem and may require quadriceps plasty **(20).**

7. Infection:

Infection may rarely complicate a closed femoral shaft fracture. Route of infection is hematogenous seeding of the hematoma and subsequent osteomyelitis. Fever is commonly associated with femoral fractures during the first week after injury, but persistent fever or fever that spikes exceedingly high may be an indication of infection **(19).**

8. Neurovascular Injury:

Nerve and vascular injuries are uncommon with femoral fractures in children. An estimated 1.3% of femoral fractures in children are accompanied by vascular injury. Nerve abnormalities reported with femoral fractures in children include those caused by direct trauma to the sciatic or femoral nerve at the time of fracture and injuries to the peroneal nerve during treatment **(20).**

9. Compartment Syndrome:

Compartment syndromes of the thigh musculature are rare but have been reported in patients with massive thigh swelling after femoral fracture and in patients treated with intramedullary rod fixation. It is probable that some patients with quadriceps fibrosis and quadriceps weakness after femoral fracture had intra- compartmental pressure phenomena **(19).**

10. complications related to elastic intramedullary nail:

Generally speaking, complications of elastic nails could be classified as minor complications that wouldn't need further unplanned surgeries and major complications that require further surgeries.

Minor complications

ESIN could cause skin irritation by the extra-osseous portion of the nails. **(21)** This skin irritation could present simply by knee pain considered a minor complication or even skin ulceration and deep infection which is considered a major complication. It warrants nail removal**. (22)**

Knee stiffness is another significant but minor complication. **(21)** Knee penetration and subsequent knee joint synovitis could complicate flexible nailing and are usually associated with a too anterior entry site of the nail. **(21)**

Major complications

Loss of reduced position, angulation, mal-union and delayed union are infrequent complications of TEN when the proper technique and size of the nails are used. Loss of position of the nails, angulation at the fracture site and very prominent nails are amongst complications that would need further surgery. Deep infection is another major complication that would require unplanned surgery for debridement and possible removal of the nails. Severe knee stiffness that needs manipulation, non-union, angular deformities that need correction are also considered major complications. **(21)**

A rarely met, but when occurs could be a serious complication; is the proximal nail penetration of the femoral neck with retrograde insertion. It has to be kept in mind, because it can be missed intra-operatively even with the use of fluoroscopic guidance for insertion of the nails. This could go asymptomatic or lead to reversible complications as neurapraxia of the sciatic nerve, which is reversible with re-positioning of the nails. It might even result in serious sequelae as femoral neck fractures and actual sciatic nerve injuries. **(23)**

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