Alnahrain University/college of medicine

Department of surgery

Different treatment modalities of femoral shaft fracture in children between (2-10years)/ literature review

Department of surgery at

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DEDICATION

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I dedicate this work to my parents,for all their love,support,and patience.

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ACKNOWLEDGMENT

Word will not be enough to express my deep gratitude and special appreciation to my supervisor Dr.Zaid Abd Ali . this is has been accomplished with great help and participation from his , which has been a great mentor and inspirational throughout the work process. His knowledge, availability, enthusiasm and patience have been vital for my development in this field of study.

Contents:

Abstract:

Background:

Femoral shaft fractures are among the most common diaphyseal fractures in children with an estimated annual incidence of 19 fractures per 100,000 children in the United States.They are also the most common pediatric fracture of the femur, accounting for up to 62 percent of all femur fracture.

Several observational studies have identified a bimodal age distribution for femoral shaft fractures with peaks in the toddler age group.

Across all age groups, boys have higher rates of femoral shaft fractures than girls.

Mortality from a femur fracture has been estimated at 1 per 600 patients, but is most often due to associated injuries sustained as a result of high energy trauma.

There are many systems for femoral fracture classification, the most important and most commonly used one is that of winquist.

There are different modalities for treatment of femoral shaft fracture which are used according to age,fracture pattern and also child's weight,associated injuries and mechanism of injury.

Objective:

To evaluate different modalities of treatment of femoral shaft fracture in children age group between(2-10)years, assess the functional outcome and compare between different modalities.

Methods:

Computerized searches were done without language restrictions from October 2018 to march 2019 using the phrase "different treatment modalities of femoral shaft fracture in children between(2-10)years " on scholar and PUBMED and a total of 8 literatures were included in this study from 1992 to 2019.

Discussion:

The result of literature revealed that the management of femoral shaft fractures in children is largely directed by the age and built of child.there is wide consensus on the non operative treatment of children less than 6 years of age.operative treatment is recommended for children more than 12 years of age.According to studies of literature review,we found the complications rate(malunion,infection…)was higher in surgical treatment than elastic stable intramedullary nailing and conservative treatment,also the hospital stay was shorter in patients treated with elastic stable intramedullary nailing than in patients treated conservitevely, and the cost of hip spica was cheaper than flexible intramedullary nailing group.

Conclusion:

- there is wide consensus on the non operative treatment of children less than 6 years of age.
- operative treatment is recommended for children more than 12 years of age.
- complications rate(malunion,infection…)was higher in operative treatment than non operative treatment.
- the hospital stay was shorter in patients treated with elastic stable intramedullary nailing than in patients treated conservitevely.
- the cost of hip spica was cheaper than flexible intramedullary nailing group.

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Introduction

Introduction

anatomy

The femur has three distinct regions: the hip, the shaft and the distal metaphysis. Proximally, the femoral head articulates with the acetabulum to form the hip joint, while distally, the femur broadens out to form the medial and lateral condyles, which articulate with the tibial plateau at the knee joint. (1)

In the coronal plane, a line drawn between the centre of the femoral head and the centre of the knee joint forms the mechanical axis. A line drawn through the centre of the shaft is termed the anatomical axis of the bone; this lies lateral to the mechanical axis ,The angle between the anatomical axis and the mechanical axis at the knee is around 7°, and this relationship is important when considering the reduction of supracondylar fractures. (1)

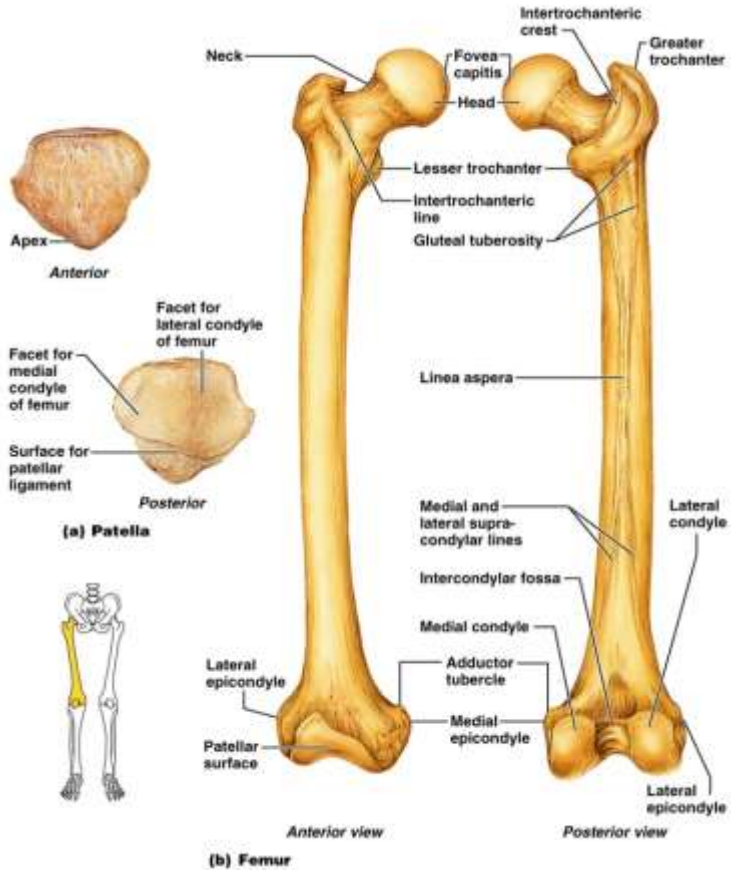

Figure 1

Musculature.

In the sagittal plane, the shaft of the femur has a marked anterior bow, with a cortical thickening posteriorly called the linea aspera. This thickening carries insertions for several important muscles: gluteus maximus, vastus lateralis and medialis, the adductors (magnus, medius and minimus) and pectineus. Distally, the gastrocnemii arise from the posterior aspect of both femoral condyles before crossing the knee joint; in supracondylar fractures, this arrangement produces the charcteristic extension of the distal fragment. [(1)]

There are three large muscle compartments in the thigh:

Anterior: Quadriceps femoris (Vastus lateralis Vastus medialis Vastus intermedius Rectus femoris) , Iliopsoas, Pectineus , Sartorius.

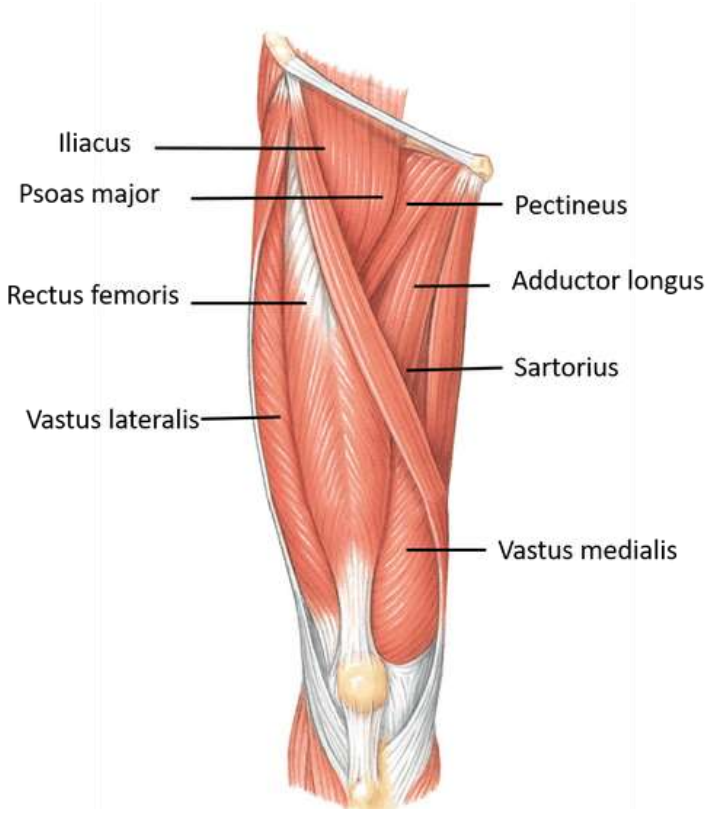

Figure 2

Medial:

Adductors (Adductor magnus, Adductor longus, Adductor brevis) , Gracilis , Obturator externus.

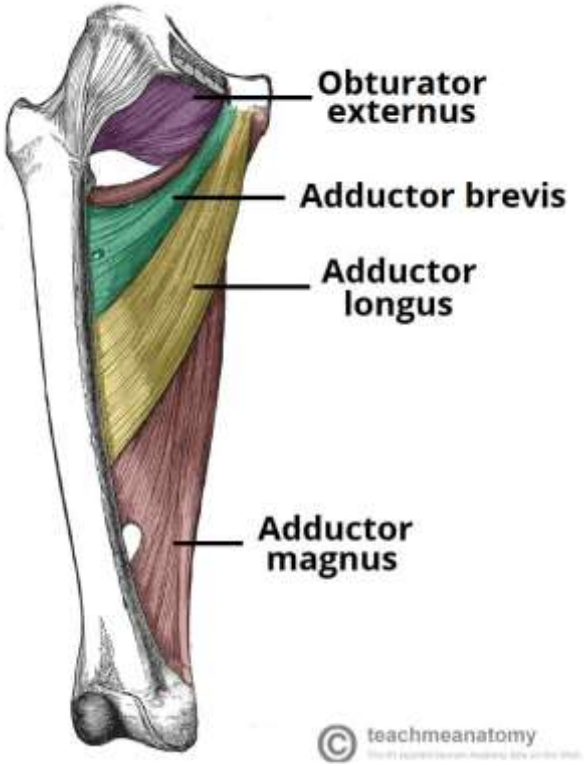

Figure 3 : Muscles of the medial thigh. The overlying muscles in the anterior compartment have been removed.

Posterior:

Hamstring muscles(Biceps femoris , Semitendinosus , Semimembranos). [(1)]

Figure 4 : The muscles of the posterior thigh (right).

Blood supply

The femoral artery divides in the anterior triangle of the thigh into the superficial femoral artery (SFA) and the profunda femoris .The SFA courses through the medial compartment, passing through Hunter's canal and the adductor hiatus to enter the popliteal fossa. Here it becomes the popliteal artery and supplies the leg. The profunda femoris artery gives rise to perforating branches, which wrap around the femur posteriorly and supply the thigh musculature. These pierce the intermuscular septum at the linea aspera to enter the lateral compartment, where they can be torn by femoral fractures, or injured during lateral exposure of the femur. Nutrient vessels arise from these perforators and run along the posterior aspect of femur in the region of the linea aspera, arborizing to provide the endosteal and periosteal blood supply. (1).

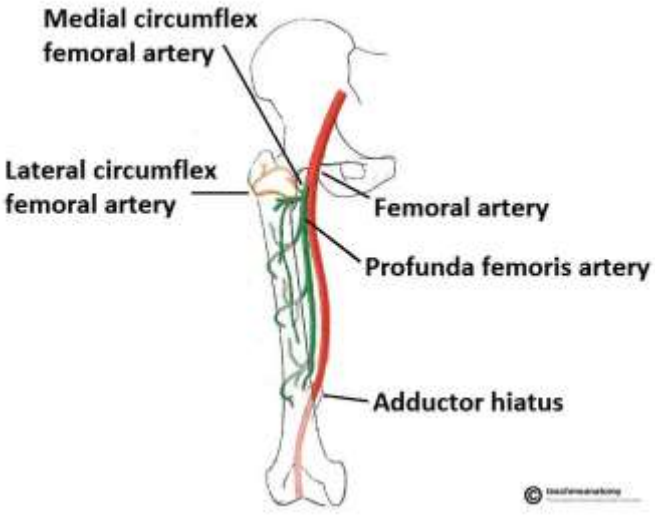

Figure 5

Femoral shaft fracture

Incidence

Femoral shaft fractures are among the most common diaphyseal fractures in children with an estimated annual incidence of 19 fractures per 100,000 children in

the United States They are also the most common pediatric fracture of the femur, accounting for up to 62 percent of all femur fractures .

Several observational studies have identified a bimodal age distribution for femoral shaft fractures with peaks in the toddler age group, where falls are the predominant cause of injury, and in the adolescent age group, where motor vehicle collisions cause most of the fractures. Across all age groups, boys have higher rates of femoral shaft fractures than girls.

Mortality from a femur fracture has been estimated at 1 per 600 patients, but is most often due to associated injuries sustained as a result of high energy trauma. (2)

Mechanism of injury

The etiology of femoral fractures in children varies with the age of the child. Before walking age, up to 80% of femoral fractures may be caused by abuse. (3)

Older children are unlikely to have a femoral shaft fracture caused by abuse, because their bone is sufficiently strong to tolerate forceful blows, or is able to resist torque without fracture.

In older children, femoral fractures are most likely to be caused by high-energy injuries; motor vehicle accidents account for over 90% of femur fractures in this age group. (4)

Although pathologic femur fractures are rare in children, it is essential that the orthopedist and radiologists study the initial injury films closely for the subtle signs of primary lesions predisposing to fracture, particularly in cases of low-energy injury from running or tripping. Radiographic signs of a pathologic fracture may include mixed lytic–blastic areas disrupting trabecular architecture, break in the cortex and periosteal reaction in malignant lesions such as osteosarcoma, or better-defined sclerotic borders with an intact cortex seen in benign lesions such as non-ossifying fibroma.

Stress fractures may occur in any location in the femoral shaft. (5,8)

In this era of high-intensity, year-round youth sports, orthopedists are more commonly encountering adolescents with femoral stress fractures from running, soccer, and basketball.23 Although uncommon (4% of all stress fractures in children), femoral shaft or femoral neck stress fractures should be considered in a child with thigh pain because an unrecognized stress fracture may progress to a displaced femoral fracture. A high index of suspicion is important, because even nontraditional sports can lead to stress fractures with extreme overuse; a recent report of bilateral femoral stress fractures were reported in a Rollerblade enthusiast. (6)

Classification

Femoral fractures are classified as (a) transverse, spiral, or short oblique; (b) comminuted or noncomminuted; and (c) open or closed. Open fractures are classified according to Gustilo's system. (7)

The presence or absence of vascular and neurologic injury is documented and is part of the description of the fracture. The most common femoral fracture in children (over 50%) is a simple transverse, closed, noncomminuted injury.

The level of the fracture leads to characteristic displacement of the fragments based on the attached muscles. With subtrochanteric fractures, the proximal fragment lies in abduction, flexion, and external rotation. The pull of the gastrocnemius on the distal fragment in a supracondylar fracture produces an extension deformity (posterior angulation of the femoral shaft), which may make the femur difficult to align. (3)

Femoral shaft fractures classification:

Winquist's classification : reflects the observation that the degrees of soft-tissue damage and fracture instability increase with increasing grades of comminution.

- In type1 there is only tiny cortical fragment.
- In Type 2 the 'butterfly fragment' is larger but there is still at least 50 per cent cortical contact between the main fragments.

- In Type 3 the butterfly fragment involves more than 50 per cent of the bone width.
- In Type 4 is essentially a segmental fracture. [11]

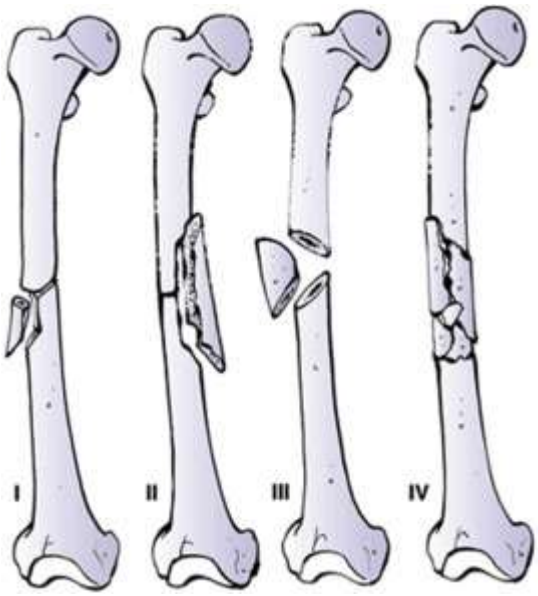

Figure 6

History and examination:

Patients with a femoral shaft fracture usually have a history of a fall or a motor vehicle accident, with pain in the thigh and an inability to walk. The history, however, may be inadequate in patients with mental retardation, nonambulatory patients, patients with polytrauma, and patients with head injury. In pathologic fractures, there may be a history of pain in the thigh and a recent increase in the pain.

In the presence of traumatic brain injury, child abuse may be suggested in children younger than 4 years who have a history of injury discordant with fracture and multiple fractures in different stages of healing.

Femoral shaft fractures are hard to miss on examination; deformity, swelling, shortening, tenderness, abnormal mobility, and crepitus suggest the diagnosis. Nevertheless, a complete physical examination must still be performed to rule out associated injuries, especially in the setting of hypotension, which is rarely due to isolated femoral shaft fractures.

Rang described the Waddel triad of femoral shaft fracture, head injury, and intra-abdominal or thoracic injury caused by automobile-pedestrian collisions. [13] Common musculoskeletal injuries associated with femoral shaft fracture that are often missed include femoral neck fracture, hip dislocation, and ligamentous injuries of the knee. (6)

Imaging

X-ray findings of femoral shaft fractures

Radiographic evaluation should include the entire femur, including the hip and knee, because injury of the adjacent joints is common. An anteroposterior (AP) pelvis x-ray is a valuable supplement to standard femoral shaft views, because there may be associated intertrochanteric fractures of the hip, fractures of the femoral neck, or physeal injuries of the proximal femur. (9)

Distal femoral fractures may be associated with physeal injury about the knee, knee ligament injury, meniscal tears, and tibial fractures. (10)

Plain x-rays generally are sufficient for making the diagnosis.

MRI

In rare circumstances, bone scanning and magnetic resonance imaging (MRI) may be helpful in the diagnosis. (3)

Complication of femoral shaft fracture

I. Early

a) local:

- Vascular injury
- Neurologic injury
- Associated injury

b) General:

- Haemorrhage: This is addressed during resuscitation but the response to fluids, blood and blood products must be reassessed throughout the acute period.
- Fat embolism and acute respiratory distress syndrome (ARDS): While 30% of patients with a long bone fracture may suffer a period of perioperative hypoxaemia, the incidence of ARDS is <1%. The risk is greater in young patients with multiple injuries. Careful monitoring throughout the acute perioperative period is required .

II. Late:

a) local:

- Delayed union or non-union
- Malunion
- Knee joint stiffness

Where it does occur, intra-articular adhesions or tethering of the quadriceps muscle (which prevents it from sliding over the distal femoral shaft) is usually responsible.

b) General:

Critical illness sequelae: Long-term systemic complications are very unusual after femoral fractures, unless the injury is accompanied by other severe injuries. [(1)]

Treatment of femoral shaft fractures

Treatment of femoral shaft fractures in children depends on two primary considerations: Age (**Table1**) and fracture pattern. Secondary considerations, especially in operative cases, include the child's weight, associated injuries, and mechanism of injury. Economic concerns, the family's ability to care for a child in a spica cast or external fixator, and the advantages and disadvantages of any operative procedure also are important factors. [(3)]

Table (1) shows the Treatment Options for isolated Femoral Shaft fracture in children

age	treatment
2-5 years	**early spica cast** **traction → spica cast** **external fixation (rare)** **flexible intramedullary nails (rare)**
6-10 years	**flexible intramedullary nails** **traction → spica cast** **Submuscular plate** **external fixation**

Treatment Variation with Age for Femoral Shaft Fractures

Preschool Children

In children 6 months to 5 years of age, early spica casting is the treatment of choice for isolated femur fractures with less than 2 cm of initial shortening.

In low-energy fractures, the "walking spica" is ideal. is a sort of orthopedic cast used to immobilize the hip or thigh. It is used to facilitate healing of injured hip joints or of fractured femurs. [(14)]

spica cast should be applied with the patient under general anesthesia. A 90-90 plaster cast or a sitting spica cast, which allows the child to be placed in a sitting position in the chair, may be applied.

The plaster is applied with 90° of flexion, 30° of abduction, and 15° of external rotation at the hip and with 90° flexion at the knee. The plaster is molded anteriorly and laterally to prevent anterior and varus bowing. Acceptable reduction comprises less than 15° of angulation and less than 2 cm of shortening. If reduction is not acceptable, the spica cast should be reapplied after remanipulation; wedging a 90-90 cast may cause peroneal nerve palsy.

The spica cast is kept in place for 4-8 weeks, depending on the age of the patient. Excessive shortening is the most common early complication of spica casting. Limb-length discrepancy greater than 2 cm has been reported in 43% of cases and unacceptable angular deformity in 10-30%. [14]

Femur fractures with more than 2 cm of initial shortening or marked instability and fractures that cannot be reduced with early spica casting require 3 to 10 days of skin or skeletal traction. Internal or external fixation is rarely needed in children less than 5 years of age. In rare circumstances, external fixation can be used for children with open fractures or multiple trauma. Intramedullary fixation is used in children with metabolic bone disease that predisposes to fracture or after multiple fractures. Flexible nailing can be used in the normal sized pre- school children but is rarely necessary. Larger children (in whom reduction cannot be maintained with a spica cast) occasionally may benefit from flexible intramedullary nailing, traction, or in rare cases, submuscular plating. [3]

Children 5 to 10 Years of Age

In children 5 to 11 years of age, many different methods can be used successfully, depending on the fracture type, patient characteristics, and surgeon skill and experience.

For the rare, minimally displaced fracture, early spica casting usually produces satisfactory results, although cast wedging or a cast change may be necessary to avoid excessive shortening and angulation. In children with unstable, comminuted fractures, traction may be necessary prior to cast application. Although traction and casting is still a very acceptable and successful method of managing femur fractures in young school-age children, the cost and the social problems related to school-age children in casts have resulted in a strong trend toward fracture fixation. Spica cast management is generally not used for children with multiple trauma, head injury, vascular compromise, floating knee injuries, significant skin problems, or multiple fractures.

Flexible intramedullary nails are the predominant treatment for femur fractures in 5- to11-year olds, although submuscular plating and external fixation have their place, especially in length-unstable fractures, or in those difficult to manage fractures in the proximal and distal third of the femoral shaft.[13]

Treatment variation with fracture pattern for femoral shaft fracture

In addition to age, the treating surgeon should consider fracture pattern, especially when choosing implant. Elastic nailing is ideal for the vast majority of length-stable midshaft femur fractures in children between the ages of 5 and 11 years old. For length-unstable fractures, the risk of shortening and malunion increases substantially when elastic nailing is used. Length- unstable fractures are best treated with locked trochanteric entry nailing in older children, external fixation in younger children, or submuscular plating in either of these age cohorts. [3]

Treatment options for femoral shaft fracture

Spica Cast Treatment for Femoral shaft fracture

Spica casting is usually the best treatment option for isolated femoral shaft fracture in children under 6 years of age,

unless there is:

a) shortening of more than 2 cm,
b) massive swelling of the thigh, or
c) An associated injury that precludes cast treatment.

The advantages of a spica cast include low cost, excellent safety profile, and a very high rate of good results, with acceptable leg length equality, healing time, and motion.

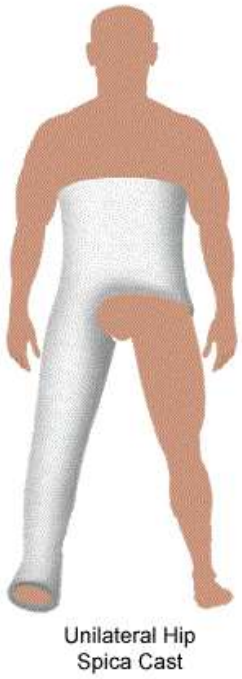

Figure 7

Complications of Spica Casting

Comparative studies and retrospective reviews have demonstrated unsatisfactory results in a small, yet significant, percent- age of patients treated with skeletal traction.

Recently, increased attention has been focused on the risk of compartment syndrome in children treated in 90/90 spica cast. Mubarak et al.151 presented a multicenter series of nine children with an average age of 3.5 years who developed compartment syndrome of the leg after treatment of a low-energy femur fracture in a 90/90 spica cast. These children had extensive muscle damage and the skin loss around the ankle .The authors emphasize the risk in placing an initial below knee cast then using that cast to apply traction while immobilizing the child in the 90/90 position. The authors recommend avoiding traction on a short leg cast, leaving the foot out, and using less hip and knee flexion.[3,21]

Flexible Intramedullary Nail Fixation for Femoral Shaft Fracture:

In most centers, flexible intramedullary nailing is the standard treatment for midshaft femur fractures in children between the ages of 5 and 11 years old. The

flexible intramedullary nailing technique can be performed with either stainless steel nails or titanium elastic nails.

The popularity of flexible intramedullary nailing results from its safety, efficacy, and ease of implant removal. The flexible nailing technique offers satisfactory fixation, enough stress at the fracture site to allow abundant callous formation, and relatively easy insertion and removal. The implants are inexpensive and the technique has a short learning curve. The primary limitation of flexible nailing is the lack of rigid fixation. Length-unstable fractures can shorten and angulate, especially in older and heavier children. Compared to children with rigid fixation, children who have their femur fracture treated with flexible nailing clearly have more pain and muscle spasm in the early postoperative period. The surgeon should take this into consideration in planning the early rehabilitation.[3,22]

Complications of Flexible Intramedullary Nailing:

Complications are relatively infrequent after flexible intramedullary nailing.[3,23]

External Fixation for Femoral Shaft Fracture:

External fixation of femoral shaft fractures offers an efficient, convenient method to align and stabilize the fractured pediatric femur. It is the method of choice when severe soft tissue injury precludes nailing or submuscular plating, when a fracture shortens excessively in a spica cast, or as part of a “damage- control” strategy. In head-injured or multiply injured patients and those with open fractures, external fixation offers an excellent method of rapid fracture stabilization. [3,24]

Complications of External Fixation

The most common complication of external fixation is pin track irritation/infection. This problem generally is easily treated with oral antibiotics and local pin site care.

Despite the complications, patients and treating physicians have found wound care and ability to lengthen through the fracture to be of great benefit of external fixation

Although joint stiffness has been noted in older patients treated with external fixation, it is relatively uncommon in children with femoral fractures unless major soft tissue injury is present.[3,25]

Literature review

1-Treatment of femur fractures in school-aged children using elastic stable intramedullary nailing: [15]

Done by Baldwin, Keitha; Hsu, Jason E.a; Wenger, Dennis R.b; Hosalkar, Harish S.b **(2011)**

This study was a systematic review of the literature to examine the outcomes and complications of ESIN in school-aged children and to critically evaluate the quality of the available literature. Although most complications were minor, some series report complication rates of more than 50%. Union rates are high. Malunion or mechanical axis malalignment, on the other hand, is common, and leg length discrepancy and overgrowth are also not unusual. Symptomatic implants are common, particularly if the distal ends of the nail are left long and prominent. ESIN is a well-accepted and reliable option for treatment of femur fractures in school-aged children. Advantages are decreased length of hospital stay, early return to function, and high union rates.

2-Surgical treatment of pediatric femoral shaft fractures : [16]

Done by Gardner, Michael J.; Lawrence, Brandon D.; Griffith, Matthew H. **(2004)**

The purpose of this review is to discuss the different clinical situations and the recommended treatment methods, as well as to characterize the latest literature and recommendations.Recent findings In the past several years, there have been significant changes in the approach to the treatment of pediatric femoral shaft fractures, particularly in school-

aged children. Young children have traditionally been treated conservatively with good results, and this method is still currently advocated.However, in children between the ages of 5 and 10, new surgical treatment modalities have been tested with good outcomes, and, as new data emerge, these methods are becoming preferable to conservative treatment.A recent shift in treatment in children between ages of 5 and 10 from nonoperative to surgical intervention has led to shorter hospital stays and earlier return to activity with reliable fracture healing.

3-RESULTS OF FEMORAL SHAFT FRACTURES IN CHILDHOOD IN RELATION TO DIFFERENT TREATMENT MODALITIES: [16]

Done by Maier M , Maier-Heidkamp P , Lehnert M , Wirbel R , Marzi I **(2003)**

The clinical and radiological results of femoral shaft fractures in childhood were evaluated and compared in relation to different treatment modalities. One hundred and one children (mean age 5+/-0,4 years). 38% of the patients were treated conservatively (mean age 2,2+/-0,5 years), 32% of the patients (mean age 6+/-0,5 years) were treated by external fixation, 17% were treated with elastic stable intramedullary nailing (ESIN, mean age 5,6+/-0,8 years) and 12% underwent other internal fixation procedures. The duration of hospital stay was significantly longer in the conservative treatment group (18+/-1,6 days) than in the external fixator (12+/-1,2 days) as well as in the ESIN group (8+/-0,9 days). Complications, i.e. secondary dislocation or infection, occurred in 25% of patients in the external fixator group,6% of the ESIN patients, and in 10% of the conservatively treated patients. Late complications,i.e.weight bearing dependent pain or hypertrophic scarring,were developed in both the conservative treatment group (4%) and in the external fixator group (19%); however,no late complications were seen in the ESIN group. For older children the ESIN method showed a low rate of complications and demonstrates the best long term results. When ESIN is not possible because of local soft tissue damage,additional

injuries,or in complex fractures, the external fixator proved to be an alternative treatment for femoral shaft fractures.

4-Comparison of compression plate and flexible intramedullary nail fixation in pediatric femoral shaft fractures: [17]

Caglar, Omur; Aksoy, Mehmet C.; Yazc, Muharremıı; Surat, Adil **(2006)** Done by

The purpose of this study was to compare the results of compression plating and flexible intramedullary nailing for pediatric femoral shaft fractures. 38 consecutive patients with 40 femoral shaft fractures were evaluated. 22 femoral segments were treated with a compression plate and 18 femoral segments were treated with flexible intramedullary nailing. The time to healing, operation time and complications were evaluated. The average operation time was statistically significantly shorter in the nailing group. 4% implant failures occurred in the compression plate group whereas1% non-union was observed in the flexible nailing group. Flexible intramedullary nailing seems to provide a high union rate with a shorter operation time when compared with plate fixation.

5-Treatment Options in Pediatric Femoral Shaft Fractures: [19]

Done by †Anglen, Jeffrey O MD*; Choi, Luke MD **(2005)**

Fracture of the femur in a pediatric patient presents special problems, and a variety of treatment options. Fractures in infants (0-18 months) may be treated successfully in a Pavlik Harness. Spica casting is safe and effective in children up to about 6 years or 100 pounds, although complications can occur and careful attention to technique is important. Surgical treatment is superior in most older or larger children or

adolescents, and in cases of multiple trauma, soft tissue injury, obesity or head injury. External fixation is minimally invasive, but carries a risk of malunion and refracture. Flexible nailing is minimally invasive and well suited to fractures of the central 2/3 of the diaphysis. In comminuted fractures, it may require supplemental external support. Plate fixation is stable and addresses the entire length of the femur.

6-Flexible intramedullary nailing versus external fixation of paediatric femoral fracture: [17]

Done by Barlas K, et al. Acta Orthop Belg. **(2006)**

Treatment outcomes were compared in two groups of children with femoral diaphyseal fractures which were treated with external fixation (20 fractures) or flexible intramedullary nailing (20 fractures). These 40 children were between 5.4 to 8.5 years of age. The duration of the operation averaged 52 minutes for the external fixator compared with 70 minutes for the flexible nail group. The time taken to gain full weight bearing, full range of movements and return to school was shorter in the flexible intramedullary nail group. There was a higher complication rate in the external fixator group than in the flexible nail group. At final review, 3 patients in the external fixator group had pain, 2 had leg length discrepancy of up to 1 cm, and 4 had malalignment of 5-10 degrees. In the nailing group, there were no leg-length discrepancies or malalignments. We recommend the use of flexible intramedullary nailing for fractures of the femoral shaft in children which require surgery, and reserve external fixation for open or severely comminuted fractures.

7-Controversies in orthopaedic trauma--management of fractures of shaft of femur in children between 6 and 10 years of age: [18]

Done by Jain A, et al. Kathmandu Univ Med J (KUMJ). **(2019)**

The age group of 6-10 years remains a controversial area with multiple studies advocating different lines of treatment. We studied the literature on treatment of femoral shaft fractures in 6 to 10 year age group over the past 25 years through PubMed search and found 79 studies dealing with management of paediatric shaft femur fractures in this age group. The treatment modalities included early or immediate hip spica, traction alone, external fixator, plating (open/minimally invasive), intramedullary nailing- rigid/flexible and intramedullary Kirschner wire. The short listed articles were studied for rate and time of union, complications such as non-union and malunion, leg length discrepancy, infection, implant impingement, refracture and cost analysis. Operative treatment is usually the preferred treatment option in this age group, as it decreases hospitalization time, decreases morbidity and allows early return of child to school.

8-Treatment of School-Age Children with Femoral Shaft Fracture: Spica Casting versus Titanium Elastic Nail Fixation: [20]

Done by Ismail Hakki Korucu, Faik Turkmen, Erdinc Acar, Veysel Basbug, Fahri Yurtgun, Serdar Toker **(2015)**

The current study aims to compare the outcomes of elastic nail to the immediate spica cast method for school-age children with femoral fracture. We evaluated the patients who had undergone immediate hip spica cast (IHSC as Group 1; n=31) or flexible intramedullary titanium nail (FITN as Group 2; n=31) for femoral fracture. Age, sex, cause of fracture, localization of the fracture, cost of treatment, times of hospitalization, radiologic and clinical assessment of femoral union, condition of the wound and soft tissue, times of union and walking were recorded. The mean follow- up was 58 (26-62) months. All fractures were healed. The time for weight-bearing and walking were shorter (39/52) in Group 2 than it was in Group 1 (52/63). In terms of cost, IHSC (114.99$) was cheaper than FITN (380.82$). Although IHSC is still a a widely accepted method of treatment, with the use of modern surgical techniques and

implants, satisfactory outcomes of fracture healing can make FITN a better surgical option among all other treatments.

DIFFERENT STUDIES	MALUNION	SHORTENING	INFECTION	HOSPITAL STAY	COST
1.	common	Not unusual	Not mention	decrease	Not mention
2.	Not mention	Not mention	Not present	Shorter with surgical intervention	Not mention
3.	4% (conservative) 19% (external fixation)	Not mention	25%(external fixation) 6%(ESIN) 10%(conservative)	12 days(external fixator) 8 days(ESIN) 18 days(conservative)	Not mention
4.	4% in compression plate group 1% in flexible nailing group	Not mention	Not mention	Not mention	Not mention
5.	Can occure in spica cast but more common with external fixation	Not mention	Not mention	Not mention	Not mention
6.	Higher in external fixator group than in flexible nail group	2% in external fixator group No shortening in nailing group	Not mention	Shorter in flexible intramedullary nail group	Not mention
7.	Not mention	Not mention	Not mention	Shorter in flexible intramedullary nail than hip spica	Immediate hip spica cast(114.99$) was cheaper than FITN (380.82$)

Discussion:

The result of literature revealed that the management of femoral shaft fractures in children is largely directed by the age and built of child.there is wide consensus on the non operative treatment of children less than 6 years of age.operative treatment is recommended for children more than 12 years of age.According to studies of literature review,we found the complications rate(malunion,infection…)was higher in operative treatment than non operative treatment,also the hospital stay was shorter in patients treated with elastic stable intramedullary nailing than in patients treated conservitevely, and the cost of hip spica was cheaper than flexible intramedullary nailing group.

Mansour et al.128 compared spica cast placement in the emergency department versus the operating room, and concluded that the outcome and complications were similar, but the children treated in the operating room had longer hospital stays and significantly higher hospital charges.

Cassinelli et al.33 treated 145 femur fractures, all in children younger than age 7, with immediate spica cast application in the emergency department. All children younger than 2 years of age, and 86.5% of children of ages 2 to 5 years old, met acceptable alignment parameters on final radiographs. Rereduction in the operating room was needed in 11 patients. The investigators concluded that initial shortening was the only independent risk factor associated with lost reduction.

Hughes et al.90 evaluated 23 children ranging in age from 2 to 10 years who had femur fractures treated with early spica casting to determine the impact of treatment on the patients and their families. The greatest problems encountered by the family in caring for a child in a spica cast were transporta- tion, cast intolerance by the child, and hygiene.

In a similar study, **Kocher109** used a validated questionnaire for assessing the impact of medical conditions on families demonstrated that for family, having a child in a spica cast is similar to having a child on renal dialysis. They found that the impact was greatest for children older than 5 years, and when both parents are working. Such data should inform the decisions of orthopedic surgeons and families who are trying to choose among the many options for young school-age children.

Illgen et al.,95 in a series of 114 isolated femoral fractures in children under 6 years of age, found that 90-degree/90-degree spica casting was successful in 86% without cast change or wedging, based on tolerance of shortening less than 1.5 cm and angulation less than 10 degrees.

Similar excellent results have been reported by **Czertak and Hennrikus41** using the 90/90 spica cast.

Thompson et al.197 described the telescope test in which patients were examined with fluoroscopy at the time of reduction and casting. If more than 3 cm of shortening could be demonstrated with gentle axial compression, traction was used rather than immediate spica casting. By using the tele- scope test, these researchers decreased unacceptable results (>2.5 cm of shortening) from 18% to 5%. Shortening is acceptable, but should not exceed 2 cm. This is best measured on a lateral x-ray taken through the cast. If follow-up x-rays reveal significant varus (>10 degrees) or anterior angulation (>30 degrees), the cast may be wedged.

Ozdemir et al.160 measured overgrowth with scanogram and found that the average increase in length was 1.8 mm,suggesting that significant femoral overgrowth is not seen with this method of treatment.

Flynn et al.59 compared traction and spica cast with titanium elastic nails for treatment of femoral fractures in 83 consecutive school aged children.the three unsatisfactory results were treated with traction followed by casting.the overall complication rate was 34% in the traction group and 21% in the elastic nail group.

The authors concluded that results were generally excellent for titanium elastic nailing,but poor result were more likely in children older than 11 years and heavier than 50 Kg.

Ho et al.87 reported a 34% complication rate in patients 10 years and older,but only 9% complication rate in patients yoyunger than 10 years,emphasizing the concept that complications of flexible nailing are higher in older,heavier children.

Aronson and tursky 6 reported their early experience with 44 femoral fractures treated with primary external fixation and early weight bearing.most patients returned to school by 4 weeks after fracture and had full knee motion by 6 weeks after the fixator was removed.

In Matzkin et ai.131 reported on a series of 40 pediatric femur fractures treated with external fixation.72% of their series were dynamized prior to external fixator removal,and their refracture rate was only 2.5%. they had no overgrowth,but one patient ended up 5cm short.

Following early enthusiasm for the use of external devices,the last decade saw waning interest in their use because of complications with pin track infections,pin site scarring,delayed union, and refracture.these complications,coupled with the very low complication rate from flexible nailing,led to decline of external fixation for pediatric femoral shaft fractures.data from comparison studies also contributed to the change.

Bar-on et al.10 compared external fixation with flexible intramedullary rodding in a prospective randomized study.they found that the early postoperative course was similar but that the time to return to school and to resume full activity was less with intramedullary fixation.muscle strength was better in the flexible intramedullary fixation group at 14 months after fracture.parental satisfaction was also significantly better in the flexible intramedullary rodding group.bar-on et al.10 recommended that external fixation be reserved for open or severely comminuted fractures.

Conclusion:

From this literature review we found:

- ✓ The etiology of femoral shaft fractures in children varies with the age of the child.
- ✓ Winquist classification is the most important one.
- ✓ Plain X-ray generally is sufficient for making the diagnosis.
- ✓ Treatment of femoral shaft fractures in children depend on age and fracture pattern.
- ✓ Spica casting is usually the best treatment option for isolated femoral shaft fracture in children under 6 years of age.
- ✓ Flexible intramedullary nailing is the standard treatment for midshaft femur fractures in children between the ages of (5-10) years old.

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