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Pediatric Femoral Shaft Fractures: A Comparative Study between Compression Plate Fixation and Flexible Intramedullary Nail Fixation

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ABSTRACT

Femoral shaft fractures are commonly isolated injuries with minor trauma. Various mechanisms of injury can cause femoral shaft fractures ranging from simple falls to severe and complex injury patterns. Spica casting procedures may associate with shortening at the fracture, loss of reduction, angulation at the fracture side and compartment syndrome. Also, Skin Traction followed by Spica casting may lead to with over-distraction,loss of position and pressure sores as complication. Operative treatment of femoral fractures including several methods using Flexible intramedullary nail, internal plate fixation and external fixation. The aim of this study to review the comparison between Compression Plate Fixation and Flexible Intramedullary Nail Fixation in treatment of Femoral Shaft Fractures in pediatrics.

Keywords: Plate Fixation;Femoral Fractures;Intramedullary Nail

INTRODUCTION

Femoral shaft fractures are commonly isolated injuries or associated with minor trauma such as abrasion or contusion. High velocity trauma in children produces unstable fracture pattern, with a constellation of more severe and life threatening injuries [(1)].Various mechanisms of injury can cause femoral shaft fractures ranging from simple falls to severe and complex injury patterns. It is important to distinguish between low and high energy injuries [(2)].Low energy mechanisms of injury can cause indirect fractures producing a typical spiral or oblique fracture, and usually they are associated with closed fractures with minor soft tissue trauma [(3)].

Femoral fractures can be classified in many ways. Usually, Surgeons have always used simple classification such as whether the fracture was open or closed or whether it was located in the upper, middle or lower thirds of thebone.The most comprehensive classification of femoral fractures is AO classification [(4)].

The Gustilo open fracture classification system is the most commonly used classification system for open fractures. It was created by Ramón Gustilo and Anderson, and then further expanded by Gustilo, Mendoza, and Williams. The classification depends on degree of soft tissue injury, degree of contamination, amount of periosteal damage and the requirement for vascular surgery[(5, 6)]. According to the AO: pediatric comprehensive classification of long bone fractures, shaft femur fractures are classified **(Figure 1)** [(7, 8)].

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Soft tissue injuries are an intrinsic component of any fracture. Treatment of these soft tissue injuries is challenging, but it is an integral element of fracture care. The initial evaluation of a patient with orthopedic trauma must include a detailed assessment of the soft tissue envelope. The timing and method of fracture fixation aredirectly influenced by the degree of trauma to the overlying soft tissues and have been shown to have a direct effect on postoperative function. Various classification systems have been proposed to help communicate, classify, and guide the treatment of soft tissue injuries occurring with fractures. [9]The Winquist and Hansen classification is a system of categorizing femoral shaft fractures **(Table 1)** based upon the degree of comminution[10].

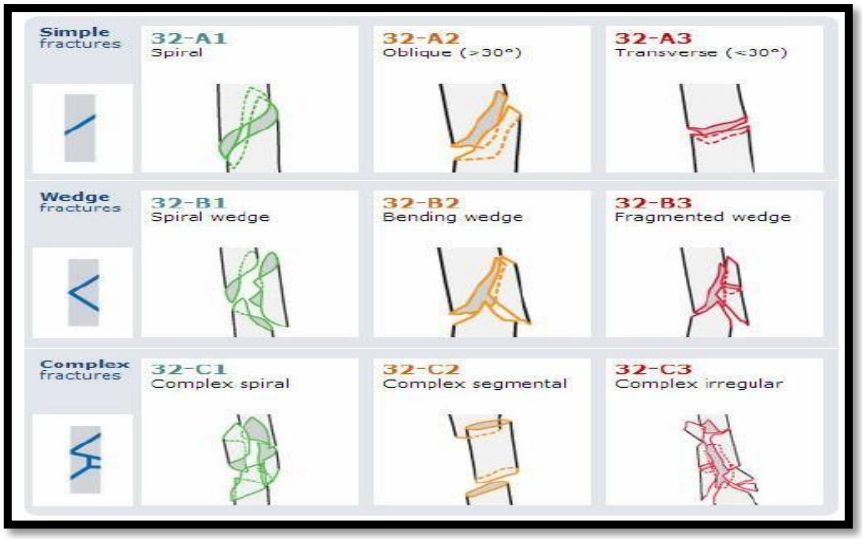

Figure (1): AO classification of the femur [8]

Table (1): Winquist and Hansen Classification. [10]

Type 0	No comminution
Type I	Insignificant amount of comminution
Type II	Greater than 50% cortical contact
Type III	Less than 50% cortical contact
Type IV	Segmental fracture with no contact between proximal and distal fragment

Non-operative treatment includes Spica casting which indicated for Simple metaphysealfracture in children 1-6 yearsold. The cast applied after reduction under sedation or generalanesthesia.Single-leg spica or one-and-one-half spica (to controlrotation).Hips flexed 30-60° and approximately 30°of abduction.External rotation is typically needed to correct a rotationaldeformity**(Figure 2)**. The goal of reduction should include obtaining < 10° of coronal plane and < 20°of sagittal plane deformity with no more than 2cm of shortening or 10° of rotational malalignment.

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However, it may complicated with shortening at the fracture, loss of reduction, angulation at the fracture side and compartment syndrome[11].

Figure (2): show unilateral hip spica cast effective for low energy fractures. [12]

Skin Traction followed by spica casting indicated in younger patients with significant shortening. The Thomas applied after reduction under general anesthesia with care to the bony prominences to avoid pressure necrosis**(Figure 3)**.Used for 2-3 weeks to allow early callus formation, and to avoid redisplacment by action of muscles[12]. Spica casting then applied until fracture healing. However, this technique may complicated with over-distraction,loss of position and pressure sores[14].

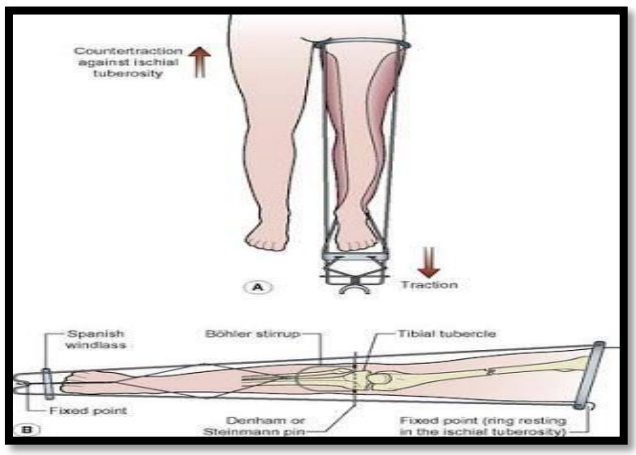

Figure (3): Shows skin traction as a primary treatment[12]

Operative treatment of femoral fractures including some of the techniques include closed reduction and internal fixation (CRIF) with elastic nails, open reduction and internal fixation (ORIF) with compression plates, external fixators and skin traction with spica casting.

I.Flexible intramedullary nails (FIN):

The FIN can be used in children with fracture shaft of femur withmultiple system injury, multiple fractures and some pathologic fractures.Most length stable fracture patterns in children 5- 14 years old weighing <49kg. [14] Social indication: When conservative treatment alternatives are unacceptable to patient'sparents **(Figure 4)**[15].By using nail size determined by multiplying the widthof the isthmus of femoral canal by0.4. The goal is 80% canal fill[16]. This techniques is

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contraindicated in case of Intra articular fractures and complex femoral fractures, particularly in connection with over weight (50-60kg) or age (15 years ormore). Also, in supracondylar fracturefemur[14].

The most common complication is pain at insertion site near the knee due to Soft tissueirritation. Also incomplete union and torsionaldeformities[16].

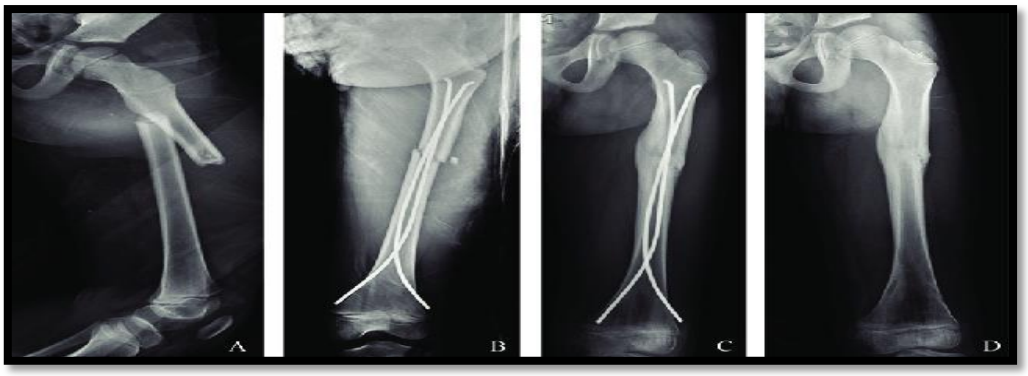

Figure (4): Xray AP&lat views showing femoral shaft fracture treated with TENs. [15]

II. Plate fixation:

This technique indicated in case of failed conservativetreatment, unstable simple fractures in children >5 years old and >49kg.Very proximal or very distalfractures and severecomminution[17].

Typically use 4.5mm narrow LC-DC plate with 3 screws proximal and 3 screws distal to thefracture.Plate may need to be bent to accommodate the natural bend of the femur **(Figure 5).**The complications associate with Plate fixation were hardware removal, refracture following hardware removal and possiblility of infection[17].

Figure (5): X-ray showing post reduction by plate in shaft femur. [18]

III. External fixation:

It indicated for poly trauma patient, openfractures, associated vascular injuries requiring vascularrepair and segmental or significantly comminutedfractures[19]. External fixation technique can be used as temporary or finaltreatment.

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Appliedlaterally and 10-16 weeks of fixation is typically needed for union and graduated weight-bearing**(Figure 6)**[20]. The complication that occurring during external fixation as risk of pin tract infections, higher rates of delayed union, nonunion andmalunion. Also, increased risk of re-fracture (1.5-21%) after removal of fixator especially withvarus[21].

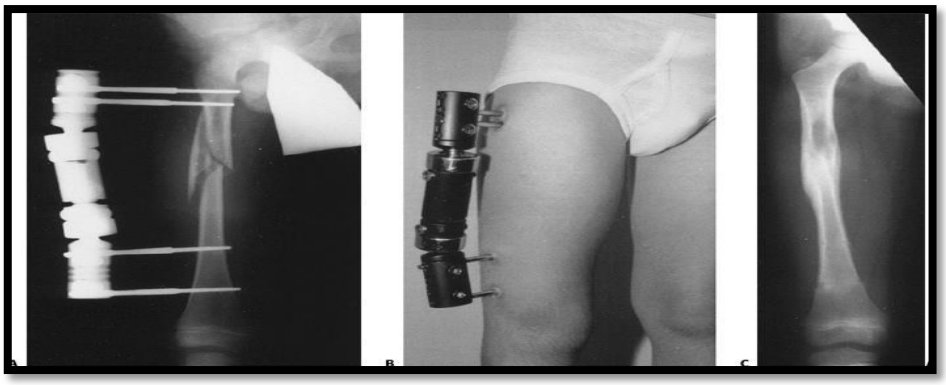

Figure (6**): Using external fixator for comminuted mid shaft femur[21].**

Although a thorough literature review and screening the study through a watchful institutional review board was done,the primary outcome assessment was restricted in the study.

CONCLUSION

There is a significant association between fracture type and treatment method, so the various fracture and patient factors that should inform implant choice and operative planning are still being determined.

No Conflict of interest.

REFERENCES

1- **Orsborn R, Haley K, Hammond S, Falcone RE**. Pediatric pedestrian versus motor vehicle patterns of injury debunking the myth : Air Med J. Jul-Sep;1999;18(3):107-10.
2- **Hedlund R, Lindgren U.** The incidence of femoral shaft fractures in children and adolescents. Journal of pediatric orthopedics. 1986;6(1):47-50.
3- **Enninghorst N, McDougall D, Evans JA, Sisak K, Balogh ZJ.** Population-based epidemiology of femur shaft fractures. The journal of trauma and acute care surgery. 2013;74(6):1516-20.
4- **Thomas P. Rüedi; Richard E. Buckley; Christopher G. Moran.** AO principles of fracture management 2007. Volume 1. Thieme. PP 503- 560.
5- **Gustilo RB, Anderson JT.** Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. JBJS Am. 1976;58:453–458.

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 06, 2021

6- **Gustilo RB, Mendoza RM, Williams DN.**Problems in themanagement of type III (severe) open fractures: A new classification of type III open fractures. J Trauma. 1984; 24:742–6.

7- **Slongo TF, Audigé L, AO Pediatric Classification Group**, Fracture and dislocation classification compendium for children: the AO pediatric comprehensive classification of long bone fractures (PCCF). J Orthop Trauma. Nov-Dec;(2007) 21(10 Suppl):S135-60.

8- **Muller, M. E.; AllgWer, M.; Schneider, R.; Willeiegger, H**. The comprehensive classification of fractures of long bones. 1991, 118-50.

9- **Ibrahim DA, Swenson A, Sassoon A, Fernando ND.** Classifications In Brief: The Tscherne Classification of Soft Tissue Injury. Clinical Orthopaedics and Related Research. 2017;475(2):560-564.

10- **Winquist RA, Hansen ST, Clawson DK**. Closed intramedullary nailing of femoral fractures. A report of five hundred and twenty cases. J Bone Joint Surg Am. 1984 Apr;66(4):529-39.

11- **Tisherman RT, Hoellwarth JS, Mendelson SA**. Systematic review of spica casting for the treatment of paediatricdiaphyseal femur fractures. Journal of children's orthopaedics. 2018;12(2):136-44.

12- **Neil EG, Marc FS. In: editor**. Fractures of the femur in children, chapter 15.Skeletal trauma in children. 3rd ed. 2013. 559–560.

13- **Vanlaningham CJ, Schaller TM, Wise C.** Skeletal versus skin traction before definitive management of pediatric femur fractures: a comparison of patient narcotic requirements. Journal of pediatric orthopedics. 2009;29(6):609-11.

14- **Imam MA, Negida AS, Elgebaly A, Hussain AS, Ernstbrunner L, Javed S, et al.** Titanium Elastic Nails Versus Spica Cast in Pediatric Femoral Shaft Fractures: A Systematic Review and Meta-analysis of 1012 Patients. The archives of bone and joint surgery. 2018;6(3):176-88.

15- **Saikia KC, Bhuyan SK, Bhattacharya TD, Saikia SP.** Titanium elastic nailing in femoral diaphyseal fractures of children in 6–16 years of age : Indian J Orthop 2007; 41:381–385.

16- **Ubel A, Andermahr J, Isenberg J**. Experience with elastic stable intramedullary nailing (ESIN) of shaft fractures in children. Orthopade 2005; 33:928–935.

17- **Hansen TB**. Fractures of the femoral shaft in children treated with an AO-compression plate: report of 12 cases followed until adulthood.ActaOrthop Scand. 2006;63(1):50-2.

18- **Ward WT, Levy J, Kaye A.** Compression plating for child and adolescent femur fractures . J PediatrOrthop. 2005; 12:626-32.

19- **Tolo VT**.External skeletal fixation in children's femoral fractures. J PediatrOrthop 2005; 3:435–442.

20- **Gregory RJ, Cubison TC, Pinder IM, Smith SR** . External fixation of lower limb fractures in children. J Trauma. 2006; 33(5):691-3.

21- **Kirshenbaum D, Albert MC, Robertson WW, Davidson RS** . Complex femoral fracture in children: treatment with external fixation. J PediatrOrthop. 2008; 10:588-91.