Submuscular Plating in Spiral Unstable Pediatric Femur Fractures

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Abstract: Introduction: The treatment of pediatric diaphyseal femur fractures, particularly spiral-unstable fractures, still an area of controversy in patients from age 4 to skeletal maturity. Submuscular plating is a method that allows for stable internal fixation without extensive soft tissue damage. **Aim of the work:** is to evaluate the clinical and radiological outcome of spiral unstable femur fractures in children treated with sub muscular plating. **Method:** A series of 15 patients of spiral femur fractures treated with submuscular plating have been reviewed after surgery. All the operations were performed using image intensifier to aid reduction of the fracture and to guide screw placement.10 patients were males and 5 were females. There were 9 right femurs and 6 left femurs. Mechanisms of injury included: fall from height (9), and MVA (6). **Results:** Mean time for full weight bearing was (11.13) weeks (range, 8 to 18 wk). All patients were radiographically healed by their (12) week assessment. There were no intra operative complications. **Conclusion:** Our technique of surgical intervention has simplified both implantation and removal, and produced comparable and excellent union rates, low complication rates, and early return to full weight bearing.

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1. Introduction

Femoral shaft fractures are among the most common fractures in children that require hospital admission. Treatment of pediatric femoral shaft fractures still bears some controversy especially when became unstable.[1]

Submuscular bridge plating is an accepted method of treatment for pediatric femur fractures.[2] Our work aim is to evaluate clinical and radiological outcome of spiral unstable diaphyseal femur fracture in 20 children treated by submuscular plating.

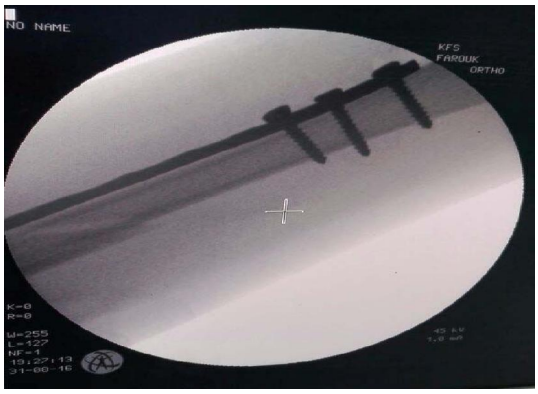
Patients And Methods

Fig. (1): two small distal and proximal incisions.

This work is both prospective and retrospective randomized clinical study on children with spiral femur fracture received in emergency department in in Al-azhar University Hospitals, and Kafr El-sheikh general hospital at Kafr El- sheikh. 15 patients have been enrolled in this study from October 2016 to August 2017. The inclusion criteria were patients with spiral unstable femur fractures, closed and first degree open fractures. The exclusion criteria were second and third degree open fractures, high velocity fractures, pathological fractures. Patients were treated by submuscular plating for the spiral unstable diaphyseal femur fractures. The age of the patients ranged from 5.5 to 14 years (average 9.20 years). Plain radiography: anteroposterior, lateral, of femur were taken. Internal fixation was done within two days from admission for all patients. The timing of surgery was affected by the degree of edema and skin condition. Patients were placed in supine position on radiolucent table. Using in-line traction, the fracture is provisionally reduced and reduction confirmed by anteroposterior and lateral views by fluoroscopy. Two incisions are made to accommodate the advancement and fixation of the plate. The proximal incision (a few centimeters long) started at the level of the vastus ridge on the greater trochanter. The fascia lata was opened and a periosteal elevator was used to elevate the vastus lateralis muscle from the bone without damaging the periosteum. The distal incision, typically starts at the level of the physis and extends proximally. In some cases the site of distal incision

was determined by the end of the chosen plate. Sharp dissection is carried down to the iliotibial band, which is split in-line with the incision. The vastus lateralis is then lifted anteriorly and extraperiosteal dissection is performed. region and extends distally approximately 2 to 3 cm. A muscle-splitting technique allows extraperiosteal dissection **(Fig. 1).**

A precontoured plate was introduced submuscularly and epiperiosteally by gently advancing in retrograde manner from distal to proximal and alignment was maintained by manual traction. The reduction was confirmed by anteroposterior and lateral views by fluoroscopy. Cortical screws are then typically placed in the proximal and distal ends of the plate to reduce the plate to the femur. Final fluoroscopic images are taken to confirm the placement of the plate and screws **(Fig. 2).**



(Fig. 2) Intraoperative fluoroscopic image

Sterile dressings are applied. Postoperatively, the limb was protected in Thomas splint for 4 weeks until subsidence of swelling and removal of stitches. Assessment of wound condition, range of motion and leg length discrepancy was done. Plain X-ray films were done postoperatively in anteroposterior, lateral views for assessment of progress of bone healing or possible complications **(Fig. 3).**

A B

Fig. (3): 2 weeks **(A)** Post operative and 8 weeks **(B)** post operative x-rays

Postoperative care includes toe-touch weight bearing from 2 to 4 weeks followed by return to activity as tolerated. Patients are typically seen 2, 6, and 12 weeks from the date of the surgery. The removal of the plate is usually performed after 6 months from the initial surgery.

Results

15 patients, including 10 males and 5 females with an average age of 9.20 years (range, 5.5 to 14 y) met inclusion criteria **(Table 1).** There were 6 left femurs and 9 right femurs. Mechanisms of injury included: fall from height (9), and motor vehicle accident (6). All patients had clinical assessments at 2, 6, and 12 weeks postoperatively. The mean time for full weight bearing was 11.13 weeks (range, 8 to 18

wk). All patients were radiographically and clinically healed by their 12 week assessment **(Table 2).**

There were no intraoperative complications. Fixation with 2 proximal and distal cluster screws occurred in all the 15 patients. There were no cases of varus or valgus malalignment. There were no cases of wound infections. No cases with heterotopic ossification. No progressive angulation was identified in any patients at final follow-up.

Table 1: Demographic data of patients.

Case NO.	Age in years	Sex	Side	Fracture location	Mechanism of trauma
1	8	Female	Left	Proximal	Motor car accident
2	12	Male	Right	Proximal	Fall from height
3	6	Female	Right	Proximal	Fall from height
4	14	Male	Left	Mid shaft	Motor car accident
5	5.5	Male	Right	Junction between proximal and middle thirds	Motor car accident
6	9	Male	Right	Mid shaft	Fall from height
7	7	Male	Left	Distal	Fall from height
8	8.5	Female	Right	Proximal	Motor car accident
9	10	Male	Right	Junction between distal and middle thirds	Fall from height
10	11	Male	Left	Junction between distal and middle thirds	Fall from height
11	9	Female	Right	Mid shaft	Fall from height
12	7	Male	Left	Proximal	Fall from height
13	7.5	Male	Right	Mid shaft	Motor car accident
14	10.5	Female	Left	Junction between proximal and middle thirds	Fall from height
15	13	Male	Right	Mid shaft	Motor car accident

Table (2): Surgical data and follow up.

Case NO.	Imobilization	Radiological union in weeks	Full weight bearing in weeks	Limp at 12 weeks	Infectioon	Swelling	Movement	Malalunion
1	Non	6	8	**NO**	**NO**	**Full range**	**No**	**Yes**
2	Thomas splint	8	10	Superfecial	No	Full range	NO	NO
3	Thomas splint	7	9	No	No	Full range	NO	NO
4	Thomas splint	10	14	No	swollen knee	Limited flexion	NO	NO
5	Thomas splint	6	9	No	No	Full range	NO	NO
6	Thomas splint	9	10	No	No	Full range	NO	NO
7	Above knee splint	12	16	No	swollen knee	Limited flexion	NO	NO
8	Thomas splint	8	11	No	No	Full range	NO	NO
9	Thomas splint	7	9	Superfecial	No	Full range	NO	NO
10	Thomas splint	10	14	No	swollen knee	Limited flexion	NO	NO
11	Thomas splint	8	10	No	No	Full range	NO	NO
12	Thomas splint	7	9	No	No	Full range	NO	NO
13	Thomas splint	12	18	No	No	Full range	NO	NO
14	Thomas splint	6	8	No	No	Full range	NO	NO
15	Thomas splint	10	12	No	No	Full range	NO	NO

Discussion

In pediatric femur fractures many options for treatment are available including different operative and conservative means; many factors like patient age, weight, fracture pattern, associated injuries, surgeon and family preferences, and socioeconomic factors tailor the appropriate treatment option.[3]

Operative treatment options include: elastic nails, plate fixation, submuscular bridge plating, external fixation and antegrade trochanteric entry nails. Operative management allows more rigid

fixation and thus more rapid mobilization and shorter period of hospitalization.[4] In spite of non operative treatment with spica casting is still a common treatment option for children younger than 5 years with an isolated injury and minimal shortening (<2 cm) [5], there is an emerging trend toward surgical treatment in older children.[6]

Elastic intramedullary nails are usually used for stable patterns of middiaphyseal fractures in children with body weight less than 45 kg (100 pounds).[7] Elastic nails are minimally invasive but do not control shortening or rotation in unstable fracture patterns.[8] Fractures located in the proximal or distal 1/3 of the diaphysis are more difficult to treat reliably with elastic nails.[9]

External fixation is simple and also minimally invasive but there is a risk of pin tract infections, scarring, and a considerable rate of refracture.[10]

Rigid intramedullary nailing provides stable fixation, but the risk of avascular necrosis and coxa valga of the femoral head limits its use in children; however, the lateral trochanteric entry nearly avoids these complications.[11]

Classical compression plating, with a long incision and more soft tissue damage, has a higher risk of infection and delayed healing, with a reported reoperation rate of 10%.[12]

Submuscular plating for diaphyseal femur fractures was first reported for adult patients in the late 1990s.[13] The procedure began to gain acceptance among orthopaedic surgeons and has started to be used in the pediatric population. It is part of the treatment algorithm recently published in the AAOS Clinical Practice Guidelines. The advantages include a minimally invasive soft-tissue-preserving approach and relative stability that allows for early ROM (no casting or bracing is required) and reliable healing. In the AAOS guidelines, submuscular plating is an option for treatment of children aged 11 years to skeletal maturity.[14] Several authors have reported the use of submuscular plating in series ranging from 27 to 51 patients. These reports suggest fractures heal well with near-anatomic leg alignment and/or rotation and minimal leg length discrepancy (LLD). Further, the reoperation rate (for causes other than recommended plate removal) is low, ranging from 0% to 2%.[15]

Subsequent researchers have shown that the surrounding soft tissue and haematoma have an extremely important biological role, producing growth factors and other stimulators of osteoprogenitor cells that induce fracture healing and callus formation.[16]

Agus et al in 2003 reviewed their results of submuscular plating for comminuted femur shaft fractures. Fourteen patients with an average age of 11.3 years were treated with submuscular plating of the femur through two 3 to 4 cm incisions. Per their description of the procedure, the fracture site was not opened and remained untouched. All patients were followed for at least 24 months with a mean follow-up of 48 months. There were no reported leg length discrepancy or rotational deformities.[17]

In 2006, Sink et al described their technique for submuscular plating. This study included 27 patients over a 2-year span at 2 level-I pediatric trauma centers. A single distal incision followed by several small incisions allowed for percutaneous placement of screws. There were no intraoperative complications and all patients healed by 12 weeks. The plates were removed electively around 6 to 8 months through the same percutaneous incisions without difficulty. There were no cases of refracture after plate removal.[18]

Our study involves tow incisions in the lateral surface of the thigh, one distal and the other proximal without touching of the fracture site. In our technique precontouring of the plate helps in reduction of the fracture. Proximal and distal clusters of screws are used to fix the fracture. In our study the implant removal was very simple and time saving without complications. Further studies analyzing long term follow up are needed to support these findings.

Conclusion

The aim of our study is to evaluate the clinical and radiological outcomes of using an alternative method in treatment of spiral unstable pediatric femur fractures. We believed that our technique provides excellent union rates, rapid return to full weight bearing, rare complications and a very simple technique for implant fixation and removal.

References

1. Galano G, Vitale M, Kessler M, Hyman J, Vitale M. The most frequent traumatic orthopaedic injuries from a national pediatric inpatient population. J Pediatr Orthop. (2005);25:39–44.
2. Samora WP, Guerriero M, Willis L, Klingele KE. Submuscular bridge plating for length-unstable, pediatric femur fractures. Journal of Pediatric Orthopaedics. 2013 Dec 1;33(8):797-802.
3. Loder RT, O'Donnell PW, Feinberg JR. Epidemiology and mechanisms of femur fractures in children. J Pediatr Orthop (2006) 26:561–566
4. Kasser JR Femoral shaft fractures. In: Rockwood CA Jr, Wilkins KE, Beaty JH (eds) Fractures in children. Lippincott- Raven, Philadelphia, pp (1996) 1195–1230
5. Leu D, Sargent MC, Ain MC, Leet AI, Tis JE, Sponseller PD. Spica casting for pediatric femoral fractures: a prospective, randomized

controlled study of single-leg versus double-leg spica casts. J Bone Joint Surg Am. (2012);94:1259–1264.
6. Narayanan UG, Phillips JH. Flexibility in fixation: an update on femur fractures in children. J Pediatr Orthop. (2012);32(suppl1): S32–S39.
7. Flynn JM, Luedtke L, Ganley TJ, Pill SG. Titanium elastic nails for pediatric femur fractures: lessons from the learning curve. Am J Orthop. (2002);31:71–74.
8. Luhmann SJ, Schootman M, Schoenecker PL, Dobbs MB, Gordon JE Complications of titanium elastic nails for pediatric femoral shaft fractures. J Pediatric Orthop (2003) 23:443–447
9. Flynn JM, Hresko T, Reynolds RA, Blasier RD, Davidson R, Kasser J. Titanium elastic nails for pediatric femur fractures: a multicenter study of early results with analysis of complications. J Pediatr Orthop. (2001);21:4–8.
10. Ramseier LE, Bhaskar AR, Cole WG, Howard AW Treatment of open femur fractures in children: comparison between external fixator and intramedullary nailing. J Pediatr Orthop (2007) 27:748–750.
11. Gordon JE, Swenning TA, Burd TA, Szymanski DA, Schoenecker PL Proximal femoral radiographic changes after lateral transtrochanteric intramedullary nail placement in children. J Bone Joint Surg (2003) 85-A:1295–1301.
12. Caird MS, Mueller KA, Puryear A, Farley FA. Compression plating of pediatric femoral shaft fractures. J Pediatr Orthop. (2003);23:448–452.
13. Wenda K, Runkel M, Degreif J, Rudig L. Minimally invasive plate fixation in femoral shaft fractures. Injury. (1997);28(suppl 1): A13–A19.
14. Kanlic EM, Anglen JO, Smith DG, Morgan SJ, Pesa´ntez RF. Advantages of submuscular bridge plating for complex pediatric femur fractures. Clin Orthop Relat Res. 2004;426:244–251.
15. Sink EL, Hedequist D, Morgan SJ, Hresko T. Results and technique of unstable pediatric femoral fractures treated with submuscular bridge plating. J Pediatr Orthop. 2006;26:177–181.
16. Vassilios S, Efstathopoulos N, Kontakis G et al. Minimally invasive plate osteosynthesis - an update, Current Orthopaedics.2008; 22: 202-7.
17. Agus H, Kalenderer Ö, Eryanilmaz G, Ömeroglu H. Biological internal fixation of comminuted femur shaft fractures by bridge plating in children. Journal of Pediatric Orthopaedics. 2003 Mar 1;23(2):184-9.
18. Sink EL, Hedequist D, Morgan SJ, Hresko T. Results and technique of unstable pediatric femoral fractures treated with submuscular bridge plating. Journal of Pediatric Orthopaedics. 2006 Mar 1;26(2):177-81.

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