



Complications Of Plate Fixation Of Femoral Shaft Fractures In Children And Adolescents

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Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Introduction: The management of femoral shaft fractures in children is largely directed by the age and built of the child. There is wide consensus on the non-operative treatment of children less than six years of age. Operative treatment is recommended for children more than 12 years of age, only the surgical options vary. The age group of 6-12 years remains a controversial area with multiple studies advocating different lines of treatment. This study aims to critically analyze the major and minor complications that may be associated with plate fixation of pediatric shaft femoral fractures.

Materials and Methods: This prospective study was conducted at Post graduate Department of Orthopaedics, Govt. Bone and Joint Hospital an associated hospital for Govt. Medical College Srinagar from September 2018 to December 2020. A total of 30 patients with femoral shaft fractures were enrolled and were managed with closed reduction and sub-muscular plating technique and were reviewed to identify the incidence of postoperative complications.

Results: In this study 8 (23.33 %) patients had complications. Out of 30 patients 2 (6.67 %) developed hypertrophic scars at incision site, 1 (3.33 %) patient had wound infection at the distal incision site which was resolved with wound debridement and intravenous antibiotic for one week, 2 (6.67 %) patients had knee stiffness with flexion less than 80, 1 (3.33 %) patients was with apex anterior angulation and 1 (3.33 %) patient had an internal rotation deformity of 5° at final follow up.

Conclusion: The plating in paediatric patients with femoral shaft fractures appears to be a relatively safe and effective procedure.

Keywords: Children, Pediatric patients, Femoral shaft fractures, Submuscular plating, Complications

Introduction

Fractures of the femur are common injuries in pediatric patients. Fractures of the femoral shaft comprise approximately 1.6% of all bony injuries in children and are the most common pediatric orthopaedic injury that requires hospitalization. Femoral shaft fractures in children are more common in boys and follow a bimodal age distribution, with the first peak occurring during the toddler years and a second peak in adolescence. Toddlers and young children are most commonly injured from simple

falls, such as tripping while running or a fall from a low height. Older children and adolescents sustain fractures most commonly from higher-energy injuries, with nearly 90% of the femoral fractures in older children resulting from motor vehicle crashes [1, 2]. Child abuse is another etiology of femoral fractures. Battered children often present first with a fracture, and it is estimated that orthopaedic surgeons see 30% to 50% of abused children.

There has been much controversy regarding the management of these fractures, with a plethora of

research failing to reach a consensus regarding the treatment strategy of choice [3]. The treatment of femoral fractures in children is largely dependent on a child's age and size. Any treatment decision, however, involves multiple considerations as the child's weight, associated injuries, the fracture pattern, the mechanism of injury, institutional or surgeons' preferences, and economic and social concerns [4, 5].

Historically the vast majority of paediatric femoral shaft fractures have been managed conservatively [6]. Conservative measures include Pavlik harness, hip spica and preliminary traction followed by cast. Although most femoral fractures unite regardless of fracture configuration, displacement and treatment method used, complications are not infrequent. These include delayed unions, non-unions, limb length discrepancies as well as angular and torsional deformities [7]. These factors as well as economic pressures and hospital resources have driven this traditional conservative approach towards a more surgical one. The change in care plans for children and adolescents away from casting toward fixation has occurred during the past two decades. Early surgical treatment of a child with high-energy trauma, a head injury, or associated multiple trauma may reduce complications and decrease the overall hospital stay. However the most appropriate surgical approach is still controversial. Multiple fixation modalities are available to the treating surgeon, and the optimal approach is an area of ongoing controversy, particularly in 5–12-year-old child. Recently published clinical practice guidelines on pediatric femur fracture management note a lack of clear evidence to definitively recommend one fixation method over another [8, 9], because the outcomes in this population are believed to be good if an accepted method of treatment is executed effectively [5].

In adolescents and older children rigid antegrade intramedullary nailing has become the standard of care [10-14]. Though some have advocated the use of rigid nailing in children as young as 8 years of age [15], concern for iatrogenic complications, most significantly femoral head avascular necrosis (AVN) [16-18] and proximal femoral growth disturbance [18, 19], have led others to limit its use to primarily older children.

Titanium elastic intramedullary nailing is now the most commonly used treatment for femur fractures in school-aged children [4, 20]. However, through the widespread use of elastic nails over the last two decades, some limitations of the technique have emerged in treating length unstable fracture patterns [21], fractures with metaphyseal extension (proximal or distal) [22-24], and fractures in heavier (49 kg) or older (11 years) children [25]. Rates of complications associated with the technique vary widely in the published literature, ranging from 10 to 62 % overall [5, 21-30]. The most commonly described complications in these reports include insertional site pain, fracture shortening, mal-rotation, implant prominence, delayed union, and re-fracture following nail removal.

Partially in response to the better appreciated limitations of elastic and rigid nailing, the use of plate fixation for pediatric diaphyseal femur fractures has increased in recent years [31, 32]. Submuscular plating is a minimally invasive technique. It provides relative stability while maintaining fracture length and angulation [33]. There occurs minimal disruption of the healing milieu at the fracture site [34]. This technique avoids the growth plates and does not disrupt the blood supply to the femoral head [34]. The suboptimal stability associated with titanium elastic nails in length unstable fractures is avoided. The refracture rate and pin site infections with external fixation does not occur with this technique, while wound complications as well as non-union rates with traditional compression plating are avoided. Also the potential for avascular necrosis with piriformis entry intramedullary nail is not the concern with this technique.

Initial reports of the use of submuscular plating in the treatment of pediatric diaphyseal femur fractures has suggested that the technique is safe and good results can be achieved at early follow-up [35-39]; however, no study since the introduction of submuscular plating in children has focused specifically on the complications associated with the technique. The current study aims to analyze the major and minor complications that may be associated with plate fixation of pediatric diaphyseal femur fractures.

Materials And Methods

This prospective study was conducted at Post graduate Department of Orthopaedics, Govt. Bone

and Joint Hospital an associated hospital for Govt. Medical College Srinagar from September 2018 to December 2020. A total of 30 patients with femoral shaft fractures were enrolled and were managed with closed reduction and sub-muscular plating technique and were reviewed to identify the incidence of postoperative complications. Informed consent was obtained from all the parents and or legal guardians before proceeding for the surgery.

The study Inclusion Criteria were children of both sexes, children in the age group of 6-14 years, closed femur fractures, stable and unstable fractures and proximal as well as distal fractures. The exclusion criteria were age less than 6 and more than 14 years, compound and pathological fractures and poly-trauma patients.

The number of complications, time from index surgery to complication, and type of complications during the study period were recorded. For the purpose of this study, we classified complications as major or minor, with a major complication defined as any ailment related to the submuscular plate fixation that required an unplanned surgical intervention over the study period. Minor complications were defined as complications related to the submuscular plating of

diaphyseal femur fractures that did not necessitate a surgical intervention.

Results

In this study 30 patients with shaft femoral fractures were managed with closed reduction and sub-muscular plate fixation. Among enrolled population 22 (73.33 %) were males and 8 (26.67 %) were females. The mean age of the patients was 9.36 (range 6-14) years. The patient demographics, mechanism of injury and characteristics of fracture and implants used are summarized in table 1.

The average duration of surgery was 88.3 (range 45-100) minutes and average hospital stay was 8.6 (range 5-15) days.

In our study 7 (23.33 %) patients had complications. Out of 30 patients 2 (6.67 %) developed hypertrophic scars at incision site (Figure 1A), 1 (3.33 %) patient had wound infection at the distal incision site (Figure 1B) which resolved with wound debridement and intravenous antibiotic for one week, 2 (6.67 %) patients had knee stiffness with flexion less than 80°, 1 (3.33 %) patients was with apex anterior angulation (Figure 1C) and 1 (3.33 %) patient had an internal rotation deformity of 5° (Figure 1D) at final follow up.

Table 1: Demography of patients, mechanism of injury and characteristics of fracture and implants

Parameters		No. of patients	Percentage
Gender	Male	22	73.33
	Female	8	26.67
Age group	6-10 Years	19	63.33
	11-14 Years	11	36.67
Mode of trauma	Road traffic accidents	11	36.67
	Fall	19	63.33
Side	Right	16	53.33
	Left	14	46.67
Fracture Location	Distal	3	10
	Proximal	6	20
	Mid	21	70
Fracture type	Transverse	13	43.33

	Spiral	9	30
	Oblique	5	16.67
	Comminuted	3	10

Figure 1: A (Hypertrophic scar), B (Superficial wound infection), C (Apex anterior angulation), D (Internal rotation)



Discussion

Femoral shaft fractures are common injuries in pediatric patients and frequently require stabilization and fixation. Long years of experience and study have established the place of surgical management of femoral shaft fractures in children. The treatment of femoral fractures in children is largely dependent on a child’s age and size. Any treatment decision, however, involves multiple considerations: the child’s weight, associated injuries, the fracture pattern, the mechanism of injury, institutional or surgeons’ preferences, and economic and social concerns [4, 5].

Complications are common in these types of injuries but can be minimized by understanding the treatment options and adhering to proper techniques. The goals of treatment should be to ultimately obtain a healed fracture and avoid associated complications, such as nonunion or delayed union, angular or rotational deformity, unequal leg lengths, infection, neurovascular injury, disruption of the growth plate, muscle weakness and compartment syndrome [1, 2]. Each primary treatment modality has associated complications.

The aim of the present study was to analyze complications associated with the use of plate fixation of pediatric femoral shaft fractures over a 3-

year period at a single institution, which saw a significant increase in the use of plates following published descriptions of submuscular techniques in children [32, 35, 36, 40].

We found rates of complications associated with submuscular plating which are consistent with the reported in the available literature evaluating this technique and which were comparable to or much lower than studies evaluating flexible nailing. Major complications (those requiring unplanned return to the operating room) occurred in one of our patients and included deep infection requiring irrigation and debridement. Minor complications (not requiring return to the operating) occurred in 3 patients and included one case of superficial wound infection, once case of painful screw prominence leading to hardware removal and one case of delayed union.

Eighty percent of patients underwent routine hardware removal which was not considered to be a complication. The majority of the patients had their plates removed via the same minimally invasive incisions through which they were put in, though small numbers required a larger dissection.

All fractures went on to union, and there were no losses of reduction, no acute fracture malalignment, and no acute shortening seen in the postoperative period. These results suggest that plating may be a

safe and reliable technique for the fixation of even complex pediatric femur fracture patterns.

Based on a significant body of recent research, femur fractures in the pediatric population may pose a management dilemma, particularly in school-aged children. A lack of comparative evidence investigating best practices has limited the applicability of conscientious attempts at the creation of formal management guidelines [8]. The available literature does point to a number of trends, however, which have emerged to aid in decision-making regarding management in select circumstances.

Studies indicate that in patients older than 6 years, shaft femoral fractures may be best treated with operative fixation as surgery leads to shorter hospital stays, faster mobilization, less disruption of the child's social, school, and family life, and lower cost when compared with non-operative strategies [41-44]. However, there exists little agreement on the optimal type of fixation method, particularly in the 5–12-year-old child, and no prospective comparisons of the various techniques have been performed.

Rigid intramedullary nailing, flexible intramedullary nailing, and submuscular plating are all considered viable treatment options. For the older child (12 years) and adolescent, rigid intramedullary nailing is generally the treatment of choice. However, its use in younger patients is somewhat limited based on concern for iatrogenic complications, such as AVN of the femoral head and proximal femoral physeal injury [17].

Flexible intramedullary nailing is the most commonly used fixation technique for pediatric diaphyseal femur fractures, and is effective at treating length-stable fractures in younger, lighter, school-aged children. With more unstable fracture patterns, and in heavier, older children, flexible nails may be associated with relatively higher complication rates. Sink et al. [21] reported a 62 % complication rate, and a 21 % unplanned return to the operating room when titanium elastic nails were used for lengthunstable injuries. Patient weight >49 kg and age >11 years were shown by Moroz et al. [25] to be independent predictors of poor outcomes, and an overall complication rate of 47.5 % was noted in their series. In their review of 43 femoral fractures in 39 patients, Luhmann et al. [24] report complications in 49 % (5 % major and 44 % minor) and a 12 % rate of

'poor' results due to malunion, nonunion, and hardware failure, and Narayanan et al. [5] reported complications in 58 %, with a reoperation rate of 13 %.

Given the potential limitations associated with flexible intramedullary nails, some authors have expressed enthusiasm for submuscular plating as an alternative [32, 35, 36, 40]. Using minimally invasive techniques, submuscular plating can provide some of the advantages of flexible intramedullary nails—such as relative stability with bridge plating techniques in comminuted fractures and limited alteration to fracture site as plating provides a lengthstable and rotationally stable construct and is associated with less hardware prominence. Studies evaluating modern plating techniques in children have shown optimistic early results. Agus, et al. [35], in 2003, reported on 14 children undergoing bridge plating of comminuted femoral shaft fractures. In their series, all fractures united, and cases of a mild torsional deformity and a single frontal/sagittal plane deformity of 10° were the only reported complications. Similarly, Sink et al. [32], in 2006, described a series of submuscular bridge plating cases in children greater than 5 years old. In their cohort of 27 patients, they found no intraoperative or postoperative complications. However, published reports of complications with this technique do exist. Kanlic et al. report a 4 % rate of 'significant' complications, including one hardware failure and one case of refracture after plate removal. They also note an 8 % rate of LLD, all of which were treated conservatively [36]. In their 2010 report of femur fracture fixation during two time periods at a pediatric hospital, Sink et al. show that despite a significant reduction in complications with increased use of submuscular plates, there was still a 12 % complication rate when submuscular plates were used in the setting of an unstable fracture. Complications included hardware prominence necessitating removal in two patients and rotational malunion in one patient [21, 30].

This study has several limitations. First, it is retrospective in nature, which introduces several potential sources of bias and small sample size, which may have limited the ability of our analysis to show an association between patient, injury, or implant characteristics and the development of a complication.

Conclusion

The plating in paediatric patients with femoral shaft fractures appears to be a relatively safe and effective procedure.

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