

Role of mini-invasive bridge plate in the complex femoral fracture in school going children: A prospective clinical study of 30 cases

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ABSTRACT

Objective: Pediatric femoral fracture including supracondylar and subtrochanteric fracture constitutes 1.6% of all paediatric fracture. Elastic nails remain the standard treatment of choice in a midshaft transverse femoral fracture in children weighing less than 45 kg. But in subtrochanteric and spiral femoral fracture, the failure rate of elastic nails are quite high. Hence, in accordance with AAOS guidelines, we treated complex femoral fracture in children with submuscular mini-invasive bridge plate because of its advantage of minimal incision, early union with proper alignment and lower failure. **Material and Methods:** We retrospectively reviewed 30 complex femur fracture in children treated with Submuscular bridge plate by mini-invasive approach. Patients were analysed according to their age, type of fracture, time of union in weeks, complication and results were evaluated with modified Flynn's criteria. **Result:** Out of 30 patients 28 were boys and 2 were females, with an average age of 11.5 years in which Spiral fracture (n = 12), subtrochanteric fracture (n = 9), Complex Shaft fracture (n = 10). All fracture united well on an average of 11 weeks. And 29 patients has excellent results and in 1 patient there is Acceptable result. The single complication was 3 mm limb lengthening but it didn't change gait of the patient. **Conclusion:** Mini invasive bridge plating is an easy and soft tissue preserving procedure for managing complex femoral fracture in children. It has shown promising results in achieving union without any major complication. We strongly recommend the SBP in a complex femoral fracture in children.

Keywords: Spiral femoral shaft fracture, submuscular bridge plating, subtrochanteric

Introduction

Subtrochanteric femoral fracture constitutes 1.6% of all paediatric fractures.^[1,2] Despite such a small percentage, the femoral fracture is the most common paediatric fracture which requires emergency care and has recorded the highest rate of hospitalisation.^[3] Though elastic nails always remain the standard treatment of choice in a

mid-shaft transverse femoral fracture in children with weight less than 40–45 kg^[4,5] however in cases of subtrochanteric and spiral femoral fracture, elastic nails have high failure rate.^[6,7] Interlocking nails have their limitations due to the risk of avascular necrosis of femoral head and growth arrest.^[8,9] Effectiveness of plating in fixation of subtrochanteric, spiral and segmental femoral fracture is well mentioned in literature^[10,11] Still in classic compression plating, there are higher chances of complications and delayed healing due to heavy blood loss and large incision.^[12]

Hence, keeping in view of the above-mentioned techniques and their complications, the technique of submuscular bridge

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Received: 20-06-2020

Revised: 08-09-2020

Accepted: 13-09-2020

Published: 08-04-2021

Access this article online

Quick Response Code:



Website:
www.jfmpc.com

DOI:
10.4103/jfmpc.jfmpc_1210_20

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How to cite this article: Lakhani A, Bhatnagar SM, Singh GP, Gupta N, Sharma E. Role of mini-invasive bridge plate in the complex femoral fracture in school going children: A prospective clinical study of 30 cases. J Family Med Prim Care 2021;10:1188-92.

plating (SBP) is a soft tissue preserving and minimally invasive approach, which provides relative stability and uneventful healing. Other advantages of this method are decreased blood loss, less operative time as compared to ORIF (open reduction and internal fixation) and decreased intraoperative radiation as compared to nailing. In the AAOS guidelines, SBP is an excellent treatment option for femoral fracture in children.^[13] So in this article, we reviewed 30 cases of complex femoral fracture treated by SBP (submuscular bridge plating).

Aim of the study

To assess the role of SBP (submuscular bridge plate) in complex femoral fracture union in children with age less than 11 years.

Material and Methods

This study was conducted in the department of orthopaedics, MMM College & Hospital, Solan from 2015 to 2018. In this retrospective study of 3 years duration, we reviewed 30 patients of subtrochanteric and complex femoral shaft fractures treated with SBP (submuscular bridge plate).

Inclusion criteria

1. Age of patients less than 14
2. Spiral fracture
3. Proximal femur fracture
4. Comminuted diaphyseal fracture

Exclusion criteria

1. Pathological fractures
2. Simple transverse diaphyseal fracture

Our main indications for SBP were complex paediatric femur diaphyseal fractures that were spiral [Figure 1] or proximal 1/3rd (including subtrochanteric) [Figure 2]. All patients were operated after relevant investigations including X-ray and blood test.

The data was collected based on included age, nature of fracture and location, date of surgery, follow-up duration, and Time

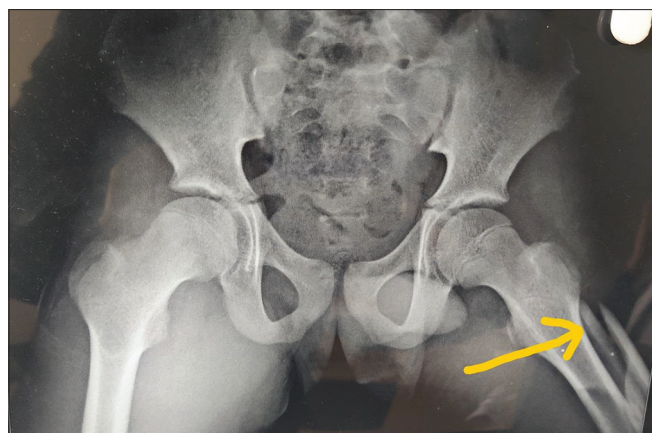


Figure 1: Complex paediatric femur diaphyseal fractures - spiral

of union [Table 1]. The results were evaluated on the basis of the leg-length inequality, malalignment, presence of pain after consolidation, or postoperative complications. All there are based on modified Flynn's criteria as shown in [Table 2].

Surgical procedure

All patients were operated on the fracture table with the operated limb on traction. We used 4.5-mm titanium narrow low contact dynamic compression plate (LCDCP) plate [Figures 3 and 4] The close reduction was achieved on the fracture table after traction and a plate were introduced sub muscularly and epiperiosteally by gently advancing it toward the opposite end. K-wires were placed through the plate hole at both ends to keep the plate in position. Fracture alignments and the reduction was rechecked in both AP and Lateral views and further cortical screws were placed at both ends of the plate to maintain reduction and plate position. After that locking screw was put to reinforce fixation and wound closed. Active movement at hip and knee started from next postoperative day.

Result

There were 28 boys and 2 girls with mean age 11.5 (8–14) years in which 12 spiral, 10 subtrochanteric and 8 fracture shaft femur [Table 1] were managed. All fractures united well with in average mean of 12.06 (8–18) weeks with formation of bridging callus was seen early at 4 weeks. Partial weight-bearing was started from 6 weeks and full weight-bearing at an average 3 months (after confirming union on X-ray) [Figures 5 and 6]. There was no infection, delayed or non-union in any case. We achieved excellent result in 29 patients and Acceptable result in 1 patient according to modified Flynn's criteria in which in all patients there was no pain, no major complication, Malalignment was <5°. There was limb lengthening of 3 mm in one case on the operative side due to fracture fixation in over traction, but it didn't change gait of the patient. All patients were followed for at least one year.

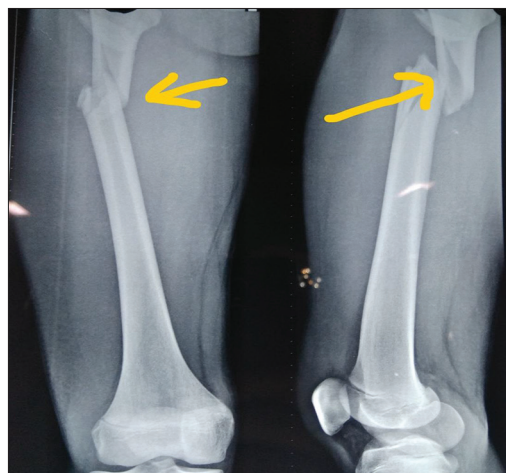


Figure 2: Complex paediatric femur diaphyseal fractures-subtrochanteric

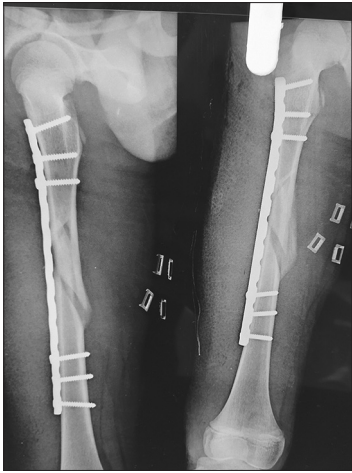


Figure 3: Showing bridge plate in spiral fracture



Figure 4: Showing bridge plate in subtrochanteric fracture



Figure 5: Showing Spiral fracture united in ten weeks post operatively



Figure 6: Showing subtrochanteric fracture united in 14 weeks

Discussion

Paediatric femoral shaft fractures are common in children and conservative approach/hip spica is the preferred mode of management in simple diaphyseal femoral shaft fracture. But in older children and complex femoral shaft fracture, conservative methods may lead to complications such as shortening, malunion or even nonunion sometimes.^[14]

There are numerous methods of managing femoral shaft fractures such as external fixation, flexible nails, compression plating and SBP.^[15] The current AAOS Clinical Practice Guidelines^[13] suggests that there is poor-quality evidence in support of any specific surgical treatment modality for managing complex diaphyseal femur fractures in children. As per guidelines the flexible nail is recommended as the treatment of choice for a patient younger than 11 years but has a higher rate of complication when used in managing proximal, spiral and in heavy children (>40–45 kg).^[16] Even with the rigid nails, proximal and distal fractures are very difficult to treat, as it requires relatively large medulla to accommodate nail and have high chances of avascular necrosis of femoral head.^[17]

Despite improvements in pin design and predictable fracture healing; external fixator remains a good choice only for open fractures and polytrauma patients^[18] because of complications such as nonunion and LLD (leg length discrepancy).

Classical compression plating requires a long incision and is associated with more soft tissue damage. There is a higher risk of infection and delayed healing due to damage to the blood supply of bone. With development, there is a tremendous increase in knowledge regarding the biology of bone healing and fixation techniques in the past few years. From the development of simple compression to stable locked plating, there are a variety of implant and fixation techniques. Bridge plating is a very well established procedure for the treatment of comminuted and complex femoral shaft fractures. It is a surgical technique in which fracture site is not exposed during the surgical procedure and indirect reduction is achieved with traction. After appropriate reduction, fixation is done by locking plates.^[19] These locking plates act as internal fixator and static tension band device [Figure 7]. The insertion of the plate is convenient from the proximal or distal end of the femur. Indirect reduction of

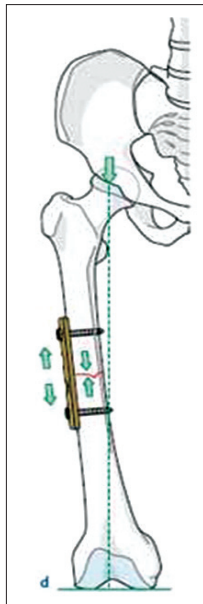


Figure 7: Showing principal of tension band device

Table 1: Patient data based on Nature of fracture, Union time in weeks

Sex	Age	Side	Nature of Fracture	Union time in weeks	Complication
male	8	right	Spiral	10	Nil
male	14	left	Spiral	12	nil
male	9	right	com. Shaft	8	Nil
male	12	left	subtochantric	14	Nil
male	13	left	subtochantric	18	Nil
female	10	left	subtochantric	12	Nil
male	9.5	right	Spiral	14	Nil
male	12	right	com. Shaft	12	Nil
male	12.5	left	subtochantric	14	Nil
male	11	right	spiral	10	Nil
male	13	right	com. Shaft	14	Nil
male	11	right	spiral	12	Nil
male	10	left	spiral	10	Nil
male	11	left	spiral	12	Nil
male	11	right	com. Shaft	10	Nil
male	8.5	right	subtochantric	14	Nil
male	12	left	com. Shaft	12	Nil
male	11.5	right	spiral	10	Nil
male	13.5	right	com. Shaft	14	Nil
male	14	Left	spiral	12	Nil
male	12	Left	subtochantric	16	Nil
male	12	Left	spiral	8	Nil
male	11	right	subtochantric	14	Nil
male	11.5	right	spiral	8	Nil
male	11	Left	subtochantric	16	Nil
male	13	Left	com. Shaft	10	Nil
male	10	Left	spiral	10	Nil
female	12	Left	subtochantric	14	Nil

the femoral fragment is easier on the fracture table because of thick integrated periosteum and muscles mass. The upper pole

Table 2: Modified Flynn’s Criteria

Flynn’s criteria	Excellent result	Acceptable result	Poor result
Leg-length inequality	<1 cm	<2 cm	>2 cm
Malalignment	5°	10°	>10°
Pain	None	None	Present
Complication	None	Minor and resolved	Major complication/ lasting Morbidity

of the patella and ASIS (anterior superior iliac spine) are useful landmarks to check rotation.

There are few studies in the literature which report SBPs are associated with high rates of union and low chance of limb shortening.^[10,20] In our study, the results were evaluated on the basis of modified Flynn’s criteria,^[21] which includes the criteria of leg-length inequality, malalignment, presence of pain and postoperative complications. All fractures united well with in average mean of 12.06 (8–18) weeks with formation of bridging callus was seen early at 4 weeks. Partial weight-bearing was started from 6 weeks and full weight-bearing at an average 3 months (after confirming union on X-ray). We have achieved uneventful healing in all cases. The single complication was 3 mm limb lengthening due to fixation in over traction on the fracture table. Our results complies with the study by Weverley *et al.*^[22] Another dilemma with plating is regarding implant removal whether metal implants in children should be removed routinely is still controversial. Up to 60% of the surgeons routinely remove hardware after bone healing.^[23] But we removed plate in single case of a female patient on request of parents. There was no complication noticed after implant removal.

Some studies preferred elastic nail for managing low grade comminuted femoral fracture in children and they used spica cast for immobilization after surgery until the union of the bone is achieved.^[24,25] However, in bridge plating, there is no additional requirement of cast or spica. which itself is an advantage to patients with regards to inconvenient due to cast.

Highlights

The concept of Submuscular bridge plating is highly recommended which help patient as well as surgeon to unnecessary avoid ORIF procedures which leads to more soft tissue damage and blood loss. The SBP has shown higher rate of union with minimally invasive approach.

Key points

1. This study will facilitate to guide and plan the management of complex femoral fracture in children.
2. In children <45 kg weight the elastic nails were remain the treatment of choice, but the failure rate of elastic nails is very high.
3. It was always recommended earlier also to treat fracture in

children with minimally invasive approach and SBP has many advantages over other procedures in treatment of complex femoral fracture in children less than 45 kg and highly appreciated according to AAOS guidelines.

4. SBP does not require any further supplementation of cast or spica which is very much uncomfortable especially in of case children.

Conclusion

Treatment of complex femoral fracture in children is controversial due to multiple treatment options and lack of universal guideline. Indeed, the current AAOS Clinical Practice Guidelines suggest individual choice and experience for managing such injuries. In our institute, we prospectively reviewed 30 complex femoral fracture in children treated with submuscular bridge plate which has advantages of preserving soft tissue vascularity and minimal incision. In all the patients union was achieved well with this minimally invasive technique. So, we strongly recommend the bridge plate for managing complex femoral fracture in children. Unnecessary traction should be avoided to get limb lengthening.

This study has been approved by ethical committee of MMMCH, Kumarhatti, Solan and there is no conflict of interest in this article.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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