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Original Research Article

Outcome Assessment of Paediatric Femur Diaphyseal Fracture Treated with Locking Compression Plate

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Abstract

Aim: The aim of the present study was to evaluate the functional and radiological outcomes of paediatric femur diaphyseal fracture treated with locking compression plate.

Material & Methods: The clinical, radiological and functional results of Submuscular plating were evaluated in 70 patients operated in between the duration of 3 years for fracture shaft humerus, shaft of femur and shaft of tibia. All the surgeries were carried out by a single surgical team at Department of Orthopaedics, PMCH, Patna, Bihar, India

Results: Among the study group, 49 were males, and 21 were females. There was a male preponderance. The youngest age among patients was six years old and the oldest age was 14 years old. The average age was 11.49 (2.08) years. Right side fractures 40 (57.14%) were more compared to left side fractures 30 (42.86%). For types of fractures, 25 (35.71%) fractures were transverse, 18 (25.72%) fractures were comminuted, 21 (30%) fractures were oblique, and 6 (8.57%) fractures were spiral. Considering the mode of injury, road traffic accident accounted for 60%, other injuries like fall during playing sports were seen in 15.71%, fall from height accounted for 8.57%. The functional outcomes were evaluated and 64 (91.42%) were excellent, 5 (7.14%) were satisfactory and 1 (1.42%) were poor.

Conclusion: Once properly planned and executed correctly the submuscular plating for diaphyseal long bone fractures is one of the reliable treatment modality. It is minimally invasive technique that allows early mobilization with satisfactory radiological and functional outcome with minimal complications.

Keywords: Fracture, Shaft, Plate, Plating, Submuscular

Introduction

Distal femoral fractures reportedly account for less than 1% of all fractures and comprise between 4%–6% of all femoral fractures. [1-3] Supracondylar femoral fractures occur commonly among two populations, young patients involved in high-energy accidents (including motor vehicle and motorcycle accidents and sports trauma) and older patients, often osteoporotic, sustaining low-energy fall fractures. Jahangir additionally described an increase of periprosthetic fractures of the distal femur in patients with previous total knee arthroplasty or distal to a total hip arthroplasty as the third common population. [4] Understanding characteristics of distal femoral fractures as well as the principles and challenges of management is important in optimizing outcomes. [5]

Majority of these fractures can be treated by conservative management using U shaped cast, velpau sling, thoracobrachial cast, brachial orthosis. [6-8] However this can lead to nonunion, delayed union, malnuion, restricted elbow and shoulder movements. [7,9] The surgical treatment includes either open reduction and internal fixation with plating or closed reduction and internal fixation with nailing. [10,11] Operative treatment and fracture fixation methods include open reduction plate fixation with locking compression plate, dynamic compression plates and bridge plating, closed reduction/open reduction with intramedullary titanium elastic nailing system (TENS), stainless steel nailing, and locked intramedullary nailing; external fixators for open fractures are used to manage femur shaft fractures in children. [12,14] TENS and plating are the common methods used for paediatric long bone fracture fixation. TENS is recommended in the paediatric age group between five to 11 years. [13,14] TENS has advantages over plating as it reduces intraoperative blood loss, has shorter operative time, is comparatively less painful, and needs shorter hospital stay. [13] TENS in selected paediatric femur diaphyseal fractures is reasonably effective. [15] TENS is suitable for middle one-third femur shaft fracture and simple fractures.

Majority of these fractures can be treated by conservative management using U shaped cast, velpau sling, thoracobrachial cast, brachial orthosis. [16-19] However this can lead to nonunion, delayed union, malnuion, restricted elbow and shoulder movements. [17,20] The surgical treatment includes either open reduction and internal fixation with plating or closed reduction and internal fixation with nailing. [21,22] Open reduction and internal fixation helps to achieve anatomical reduction but this technique requires longer surgical duration, large incision, more soft tissue dissection, blood loss and periosteal stripping which can lead to increased chances of nonunion, infection and wound healing problems. [23]

The purpose of this study was to evaluate the functional and radiological outcomes of paediatric femur diaphyseal fracture treated with locking compression plate.

Material & Methods

The clinical, radiological and functional results of Submuscular plating were evaluated in 70 patients operated in between the duration of 3 years for fracture shaft humerus, shaft of femur and shaft of tibia. All the surgeries were carried out by a single surgical team at Department of Orthopaedics, PMCH, Patna, Bihar, India

Inclusion Criteria

1. Fracture shaft of humerus, shaft of femur, shaft of tibia;
2. Fractures without any neurological deficit;
3. Patients with minimum 2 year follow up.

Exclusion Criteria

1. Compound fractures
2. Fractures with non union or delayed union
3. Pathological fractures; Neurovascular insufficiency.

Operative Technique for Humerus

The surgery was carried out in a beach chair position with the arm abducted about $40^0 – 60^0$ and supine under general anaesthesia. Indirect fracture reduction was achieved manually. With the help of C arm length of the plate, proximal and distal screw placement and skin incision was determined by keeping plate on the skin anteriorly 4-5 cm incision was made distally along lateral border of biceps approximately 5 cm proximal to flexion crease. After this an interval was made between the biceps tendon and brachioradialis muscle to expose brachailis. By blunt dissection an interval was made in the fibers of brachialis till the anterior surface of humerus was seen. Then 4-5 cm incision was made proximally and an interval was made between lateal border of proximal biceps and medial border of deltoid. An epiperiosteal tunnel connecting the two incisions was made using a plate itself. From distal to proximal incision longest possible predermined 4.5mm narrow DCP or LCDCP was slide in the tunnel. Contouring of the plate was not essential as the implant was used to provide indirect relative stable fixation and minimal cortical contact preserving periosteal blood supply. [24] Under C arm control traction was applied to restore length and any angular or rotational deformity was corrected manually. Where reduction was difficult best possible reduction was accepted. After ensuring that plate is positioned centrally on anterior surface and reduction is satisfactory it was fixed with 2 screws on each side in most proximal and most distal holes of the plate. While putting screw reduction was held by assistant and repeatedly checked under C arm. The wound was closed in layers and sterile dressing applied. The operative time was recorded from incision to closure of wound. The arm was immobilized in a cuff and collar sling Post operatively adequate antibiotic cover was given. Active shoulder and elbow exercises within pain limits were started on 2nd post op day. Patients were discharged on 5th post op day. Patients were followed up periodically till radiological bony union occurred and half yearly thereafter. Radiological assessment was done on standard anteroposterior and lateral view. At every follow up, each patient was evaluated clinically, radiographically and functionally for the signs of union, nonunion, malunion, infection.

Operative Technique for Femur

Patient supine on operation table, under all aseptic precautions scrubbing, painting and draping done. Depending on fracture site, proximal incision (4-6 centimeters long) was usually made at the level of the vastus ridge on the greater trochanter. Dissection was done to identify plane between muscle mass and periosteum over lateral cortex of femur and this plane was developed distally using a long Cobb's elevator. 4.5mm narrow low contact dynamic compression plate (LC-DCP) plates were utilized. The plate was slide in this plane from proximal to distal staying epiperiosteal. Position of plate was provisionally secured with a 1.5mm K-wire through the plate hole at one end, utilizing intraoperative imaging. The position of the other end of the plate was determined under fluoroscopy and incision was made at that level. Distal incisions were made first when fracture was in distal half of bone and plate was slide from distal to proximal in similar epiperiosteal manner. Fracture was reduced with manipulation and longitudinal traction. Folded sterile sheets were used as adjunct for reduction whenever necessary. If reduction was acceptable reduction position of plate was adjusted to maintain plate in good contact with bone and 2nd K-wire was introduced through a hole at the other end of the plate for provisional fixation. After additional evaluation and necessary adjustments were made, 3 cortical screws were inserted in either fragments. In few cases soft tissue interposition made closed reduction difficult and an incision was made at fracture site to achieve reduction with finger manipulation or a bone hook. Splints were not used in postoperative period. Postoperatively patients were mobilized within 1-3 days as per their comfort, using a walker and with the recommendation to be partial weight bearing for 6 weeks.

Operative Technique for Tibia

The surgery was carried out in supine position with angle frame under spinal anaesthesia/general anaesthesia. All surgeries were carried out by single set of surgeons. Indirect reduction was achieved manually. With the help of C arm length of plate, proximal and distal screw placement and skin incision was determined by keeping plate on anterolateral aspect of proximal tibia. Anterolateral approach used for the exposure.4-5 cm Straight incision lateral to patella taken till tibial tuberosity. Deep fascia anterior to the IT band exposed, Proximal attachment of Tibialis anterior muscle released, anterior tunnel made in the submuscular plane, longest possible 4.5 mm LCDCP/DCP slide from proximal fragment to distal fragment. Reduction achieved with controlled traction under C arm guidance, An epiperiosteal tunnel connecting the two incisions was made, precontured plate was slide in the tunnel, three proximal and three distal screws are placed, the wound was closed in layers, sterile dressing done. Bed side knee, hip, ankle were started on 1 st post op day or as per patients comfort, patient was discharged on 5th post op day, patients was mobilized with walker with non-weight bearing for 6 weeks, partial weight bearing for next 6 weeks and full weight bearing after 12 weeks.

Results

Table 1: Demographic data

Gender	N%	P Value
Male	49 (70)	0.743
Female	21 (30)	
Mean (SD) age in years	11.49 (2.08)	0.068
Side affected		
Right	40 (57.14)	0.872
Left	30 (42.86)	

Among the study group, 49 were males, and 21 were females. There was a male preponderance. The youngest age among patients was six years old and the oldest age was 14 years old. The average age was 11.49 (2.08) years. Right side fractures 40 (57.14%) were more compared to left side fractures 30 (42.86%).

Table 2: Type of fracture and Mode of injury

Type of fracture	N%	P Value
Comminuted	18 (25.72)	0.848
Oblique	21 (30)	
Spiral	6 (8.57)	
Transverse	25 (35.71)	
Mode of injury		
RTA	42 (60)	0.642
Self-fall	11 (15.71)	
Fall from height	6 (8.57)	
Sports injury	11 (15.71)	
Assault	0	

For types of fractures, 25 (35.71%) fractures were transverse, 18 (25.72%) fractures were comminuted, 21 (30%) fractures were oblique, and 6 (8.57%) fractures were spiral. Considering the mode of injury, road traffic accident accounted for 60%, other injuries like fall during playing sports were seen in 15.71%, fall from height accounted for 8.57%.

Table 3: Fracture union and complications

Fracture union in weeks	N%	P Value
Less than 12 weeks	49 (70)	0.007
12 - 17 weeks	14 (20)	
More than 18 weeks	7 (10)	
Complications		
No complications	54 (77.14)	0.210
Thigh pain	7 (10)	
Superficial Infection	3 (4.28)	
Delayed union	4 (5.71)	
Knee stiffness	2 (2.85)	

In our study, the average union time in group one was 10.5 weeks. Early complications in the form of superficial infection were in 3 patients. Late complications in the form of thigh pain in 7 patients. Cases of knee stiffness were in 2 patients and delayed union were in 4 patients.

Table 4: Functional outcomes

Functional outcomes	N%
Excellent	64 (91.42)
Satisfactory	5 (7.14)
Poor	1 (1.42)
Total	70 (100)

The functional outcomes were evaluated and 64 (91.42%) were excellent, 5 (7.14%) were satisfactory and 1 (1.42%) were poor.

Discussion

Distal femoral fractures reportedly account for less than 1% of all fractures and comprise between 4%–6% of all femoral fractures. [25-27] Supracondylar femoral fractures occur commonly among two populations, young patients involved in high-energy accidents (including motor vehicle and motorcycle accidents and sports trauma) and older patients, often osteoporotic, sustaining low-energy fall fractures. Jahangir additionally described an increase of periprosthetic fractures of the distal femur in patients with previous total knee arthroplasty or distal to a total hip arthroplasty as the third common population. [28] Understanding characteristics of distal femoral fractures as well as the principles and challenges of management is important in optimizing outcomes. [29]

Among the study group, 49 were males, and 21 were females. There was a male preponderance. The youngest age among patients was six years old and the oldest age was 14 years old. The average age was 11.49 (2.08) years. Right side fractures 40 (57.14%) were more compared to left side fractures 30 (42.86%). Considering the mode of injury, road traffic accident accounted for 60%, other injuries like fall during playing sports were seen in 15.71%, fall from height accounted for 8.57%. The fracture fixation which allows the micro movements at the fracture site under physiological stress are called as flexible fixations which aids in early union by callus formation. The healing by bridging callus is faster, effective and has more strength as compared to primary bony healing. [30] The primary bone healing without callus formation is not very strong and has risk of refracture after removal of implant which happens in the open technique. [31] It preserves blood supply, prevents periosteal stripping, soft tissue damage as the fracture site is not opened and hence prevents the devascularisation of bony fragments. It also preserves the fracture haematoma environment as the fracture site is closed. [32-35] This technique has advantage of small incision, requires short duration, prevents blood loss, avoids soft tissue dissection and periosteal stripping, hence preventing complications such as non-union and infection. [33,34]

For types of fractures, 25 (35.71%) fractures were transverse, 18 (25.72%) fractures were comminuted, 21 (30%) fractures were oblique, and 6 (8.57%) fractures were spiral. In our study, the average union time in group one was 10.5 weeks. Early complications in the form of superficial infection were in 2 patients. Late complications in the form of thigh pain in 6 patients. Cases of knee stiffness and delayed union were in 3 patients each. It has own longer learning curve. It needs experienced assistants to assist in the procedure. In any close reduction procedure some axial or rotational malalignment may exist. In humerus such minimal residual malalignment is acceptable. Submuscular plating cannot be done in pathological fracture. Also nonunion and delayed union patients are contraindicated because these need freshening of bone ends and bone grafting. Hedequist DJ and Sink E et al [36] reported 8 of their 39 patients (21%) required unplanned surgeries and found 10 of the 15 patients (66%) in the unstable fracture group had either fracture shortening or angulation. The results with sub muscular bridge plating were not affected by patient age, weight or site of fracture. It can be performed even in smaller children irrespective of the size of their medullary canals which can be a limiting factor for intramedullary nail fixation. With intramedullary nails, stability may be inadequate due to shorter bone nail contact. Sub-muscular plating reliably provides adequate stability. The functional outcomes were evaluated and 64 (91.42%) were excellent, 5 (7.14%) were satisfactory and 1 (1.42%) were poor.

Conclusion

Once properly planned and executed correctly the submuscular plating for diaphyseal long bone fractures is one of the reliable treatment modality. It is minimally invasive technique that allows early mobilization with satisfactory radiological and functional outcome with minimal complications.

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