e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(8); 173-178

Original Research Article

A Hospital-Based Outcome Assessment of Submuscular Plating for Diaphyseal Long Bone Fractures: An Observational Study

Angad Kumar Choudhury[1], Dilip Kumar Singh[2]

[1]Senior Resident, Department of Orthopaedics, Jawahar Lal Nehru Medical College and Hospital, Bhagalpur, Bihar, India

[2]Professor and HOD, Department of Orthopaedics, Jawahar Lal Nehru Medical College and Hospital, Bhagalpur, Bihar, India

Received: 10-01-2023 Revised: 20-02-2023 / Accepted: 25-03-2023

Corresponding author: Dr. Angad Kumar Choudhury

Conflict of interest: Nil

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 50 patients operated in between the duration jan 2018 to December 2019 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, Jawahar Lal Nehru medical college and Hospital, Bhagalpur, Bihar, India.

Results: Among the study group, 34 were males, and 16 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 10.60 (2.08) years. Right side fractures 28 (56%) were more compared to left side fractures 22 (44%). Considering the mode of injury, road traffic accident accounted for 58%, other injuries like fall during playing sports were seen in 18%, fall from height accounted for 8%. For types of fractures, 18 (36%) fractures were transverse, 12 (24%) fractures were comminuted, 16 (32%) fractures were oblique, and 4 (8%) 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. The functional outcomes were evaluated and 45 (90%) were excellent, 4 (8%) were satisfactory and 1 (2%) 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

Incidence of humerus shaft fracture in adult population is 3 to 5% approximately and it comprises 20% of all humerus fractures. [1,2] Diaphyseal femur fractures are commonly seen in the paediatric age group as there is an increase in incidence due to road traffic accidents. [3] It is more commonly seen in males. [4] Children of less than five years have good remodelling potential. So fractures in this age group can be managed conservatively with traction and hip spica application. [5] Children of more than five years with displaced femur shaft fracture require operative management to prevent complications like limb length discrepancy, non-union, malalignment, and growth disturbances. [6,7]

Majority of these fractures can be treated by conservative management using U shaped cast, velpau sling, thoracobrachial cast, brachial orthosis. [8,9,10] However this can lead to nonunion, delayed union, malnuion, restricted elbow and shoulder movements. [9,11] The surgical treatment includes either open reduction and internal fixation with plating or closed reduction and internal fixation with nailing. [12,13] 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. [14]

The incidence of nonunion with such techniques is 2 to 10%, infection 2 to 4% and radial nerve palsy is 2 to 5%. 9 Femoral shaft fractures account for 1.4% to 1.7% of all fractures seen in paediatric population. [15] Treatment for paediatric femoral fractures has been evolving from conservative to operative intervention especially in older children, more than 5 years of age. In comminuted fracture, unstable fracture, and diaphyseal femur fracture, submuscular plating has given good results compared to elastic intramedullary nailing. [16] The plating method offered good rotation stability of fracture fragments. Malalignment and limb length discrepancy were minimal in the plating method compared to intramedullary TENS. [17] In the literature, various methods are used to treat paediatric diaphyseal femur fracture.

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 50 patients operated in between the duration jan 2018 to December 2019 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, Jawahar Lal Nehru medical college and Hospital, Bhagalpur, 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-unionor delayed union
3. Pathological fractures; Neurovascular insufficiency.

2.1. 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. [18] 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	34 (68)	0.720
Female	16 (32)	
Mean (SD) age in years	10.60 (2.08)	0.064
Side affected		
Right	28 (56)	0.850
Left	22 (44)	

Among the study group, 34 were males, and 16 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 10.60 (2.08) years. Right side fractures 28 (56%) were more compared to left side fractures 22 (44%).

Table 2: Type of fracture and Mode of injury

Type of fracture	**N%**	**P Value**
Comminuted	12 (24)	0.832
Oblique	16 (32)	
Spiral	4 (8)	
Transverse	18 (36)	
Mode of injury		
RTA	29 (58)	0.680
Self-fall	8 (16)	
Fall from height	4 (8)	
Sports injury	9 (18)	
Assault	0	

Considering the mode of injury, road traffic accident accounted for 58%, other injuries like fall during playing sports were seen in 18%, fall from height accounted for 8%. For types of fractures, 18 (36%) fractures were transverse, 12 (24%) fractures were comminuted, 16 (32%) fractures were oblique, and 4 (8%) fractures were spiral.

Table 3: Fracture union and complications

Fracture union in weeks	**N%**	**P Value**
Less than 12 weeks	35 (70)	0.005
12 - 17 weeks	9 (18)	
More than 18 weeks	6 (12)	
Complications		

No complications	36 (72)	0.220
Thigh pain	6 (12)	
Superficial Infection	2 (4)	
Delayed union	3 (6)	
Knee stiffness	3 (6)	

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.

Table 4: Functional outcomes

Functional outcomes	N%
Excellent	45 (90)
Satisfactory	4 (8)
Poor	1 (2)
Total	50 (100)

The functional outcomes were evaluated and 45 (90%) were excellent, 4 (8%) were satisfactory and 1 (2%) were poor.

Discussion

Distal femoral fractures reportedly account for less than 1% of all fractures and comprise between 4%–6% of all femoral fractures. [19-21] 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. [22] Understanding characteristics of distal femoral fractures as well as the principles and challenges of management is important in optimizing outcomes. [23]

Among the study group, 34 were males, and 16 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 10.60 (2.08) years. Right side femur shaft fractures 28 (56%) were more compared to left side femur shaft fractures 22 (44%). Considering the mode of injury, road traffic accident accounted for 58%, other injuries like fall during playing sports were seen in 18%, fall from height accounted for 8%. 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. [24] 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. [25] 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. [26-29] 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. [27,28]

For types of fractures, 18 (36%) fractures were transverse, 12 (24%) fractures were comminuted, 16 (32%) fractures were oblique, and 4 (8%) 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. technically demanding and difficult to start with. 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. high rate of malunion.44–51 Sink et al [30] 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 45 (90%) were excellent, 4 (8%) were satisfactory and 1 (2%) 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.

References

1. Mahabier KC, Vogels LM, Punt BJ, Roukema GR, Patka P, Van Lieshout EM. Humeral shaft fractures: retrospective results of non-operative and operative treatment of 186 patients. Injury. 2013 Apr 1;44(4):427-30.
2. Schemitsch EH, Bhandari M. Fractures of the humeral shaft. In: rauma S, editor. Basic Science, Management and Reconstruction vol. 2. Philadelphia: Saunders; 2008. p. 1593–4.
3. Engström Z, Wolf O, Hailer YD. Epidemiology of pediatric femur fractures in children: the Swedish Fracture Register. BMC musculoskeletal disorders. 2010 Dec; 21:1-8.
4. Hedlund R, Lindgren U. The incidence of femoral shaft fractures in children and adolescents. Journal of Pediatric Orthopaedics. 1986 Jan 1;6(1):47-56.
5. Hunter JB. Femoral shaft fractures in children. Injury. 2005 Feb 1;36: A86-93.
6. Allen JD, Murr K, Albitar F, Jacobs C, Moghadamian ES, Muchow R. Titanium elastic nailing has superior value to plate fixation of midshaft femur fractures in children 5 to 11 years. Journal of Pediatric Orthopaedics. 2017 Mar 1;38(3):e111-7.
7. JH B. Beaty JH. Operative Treatment of Femoral Shaft Fractures in childrem and Asolescents. Clin Orthop Relat Res. 2005; 434:114-22.
8. Sarmiento A. Functional bracing of fractures of the shaft of the humerus. Orthopedic Trauma Directions. 2008 Jan;6(01):33-7.
9. Taha MM. The outcome of conservative treatment of closed fracture shaft humerus in adult patients. Am Med J. 2011;2(1):32-9.
10. Superti MJ, Martynetz F, Falavinha RS, Fávaro RC, Villas Boas LF, Mussi Filho S, Martynetz J, Ribas B. Evaluation of patients undergoing fixation of diaphyseal humeral fractures using the minimally invasive bridge-plate technique. Revista Brasileira de Ortopedia. 2012; 47:310-7.
11. Walker M, Palumbo B, Badman B, Brooks J, Van Gelderen J, Mighell M. Humeral shaft fractures: a review. Journal of shoulder and elbow surgery. 2011 Jul 1;20(5):833-44.
12. Strohm PC, Reising K, Hammer T, Sudkamp NP, Jaeger M, Schmal H. Humerus shaft fractures-where are we today. Acta Chir Orthop Traumatol Cech. 2011 Jan 1;78(3):185-9.
13. Bhandari M, Devereaux PJ, D Mckee M, H Schemitsch E. Compression plating versus intramedullary nailing of humeral shaft fractures—a meta-analysis. Acta orthopaedica. 2006 Jan 1;77(2):279-84.
14. Anglen JO, Choi L. Treatment Options in Pediatric Femoral Shaft Fractures. J Orthop Trauma. 2005;19(10):724–33.
15. Rockwood and Wilkin's Fractures in children. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2006.
16. Li Y, Hedequist DJ. Submuscular plating of pediatric femur fracture. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2012 Sep 1;20(9):596-603.
17. Raffaele V, Marco L, Fabrizio D, Giulia M, Giovanni N, Giulio M. Locking plate fixation in pediatric femur fracture: evaluation of the outcomes in our experience. Acta Bio Medica: Atenei Parmensis. 2016;90(Suppl 1):110.
18. Imarisio D, Trecci A, Sabatini L, Scagnelli R. Treatment for proximal humeral fractures with percutaneous plating: our first results. Musculoskeletal surgery. 2013 Jun; 97:85-91.
19. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. Injury. 2006 Aug 1;37(8):691-7.
20. Martinet O, Cordey J, Harder Y, Maier A, Bühler M, Barraud GE. The epidemiology of fractures of the distal femur. Injury. 2000 Sep 1; 31:62-94.
21. Wähnert D, Hoffmeier K, Fröber R, Hofmann GO, Mückley T. Distal femur fractures of the elderly—different treatment options in a biomechanical comparison. Injury. 2011 Jul 1;42(7):655-9.
22. Jahangir AA, Cross WW, Schmidt AH: Current management of distal femoral fractures. Current Orthopaedic Practice 2010, 21:193–197.
23. Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA, Prokuski L, Sirkin MS, Ziran B, Henley B, Audigé L. Fracture and dislocation classification compendium-2007: Orthopaedic Trauma Association classification, database and outcomes committee. Journal of orthopaedic trauma. 2007 Nov 1;21(10): S1-6.
24. Shetty MS, Kumar MA. Minimally invasive plate osteosynthesis for humerus diaphyseal fractures. Indian J Orthop. 2011;45(6).
25. Breedervad RS, Patka P, Maurik JCV. Refracture of the femoral shaft. Neth J Surg. 1985; 37:114.
26. Lau TW, Leung F, Chan CF, Chow SP. Wound complication of minimally invasive plate osteosynthesis in distal tibia fractures. Int Orthop. 2008;32(5):697–703.
27. Gupta RK, Rohilla RK, Sangwan K, Singh V, Walia S. Locking plate fixation in distal

metaphyseal tibial fractures: series of 79 patients. Int Orthop. 2010; 34:1285–90.
28. Ronga M, Longo UG, Maffulli N. Minimally Invasive Locked Plating of Distal Tibia Fractures is Safe and Effective. Clin Orthop Relat Res. 2010;468(4):975–82.
29. Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally Invasive Plate Osteosynthesis: Does Percutaneous Plating Disrupt Femoral Blood Supply Less Than the Traditional Technique? J Orthop Trauma. 1999;13(6):401–6.
30. Hedequist DJ, Sink E. Technical aspects of bridge plating for pediatric femur fractures. Journal of orthopaedic trauma. 2005 Apr 1;19(4):276-9.