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Original Research Article

Comparison of orthogonal versus parallel double plating technique in patients type C distal humeral fractures: a randomised control trial

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ABSTRACT

Background: Distal humerus fracture accounts approximately 2%-6% of all fractures and 30% of all elbow fractures, intra articular distal humerus fracture are rare accounting 0.5% of all fractures. These fractures had bimodal distribution, with respect to age and gender, with peaks of incidence in males aged 12 to 19 years and females aged 80 years and over.
Methods: Patients were randomly divided into two groups, one undergoing perpendicular plating with 17 patients and the other parallel plating with 17 patients. Patients were followed up minimally for 12 months.
Results: We observed that time of union for parallel plating method was 12.82 weeks and 12 weeks in orthogonal plating. In our study functional outcome based upon Mayo elbow performance score, in group 1 (Parallel plating) was excellent in 7 patients (41.17%), good in 6 patients (35.29%), fair in 4 patients (23.52%).
Conclusions: In terms of arc of motion and stability a good to excellent functional outcome was achieved in >85% of the study group. In cases of osteoporotic and comminuted bones, a rigid construct must be achieved.

Keywords: Distal humerus fracture, Orthogonal plating, Parallel plating, Mayo Elbow performance score

INTRODUCTION

Distal humerus fracture accounts approximately 2%-6% of all fractures and 30% of all elbow fractures, intra articular distal humerus fracture are rare accounting 0.5% of all fractures.[1] These fractures had bimodal distribution, with respect to age and gender, with peaks of incidence in males aged 12 to 19 years and females aged 80 years and over.[2] In young age group distal humerus fracture cause due to high velocity trauma like motor vehicle accidents, side swipe injuries and fall from height etc. In old age group with more osteoporotic bone, these injuries occur due to low energy trauma like simple fall.[3]

The traditional conservative managements like cast or posterior slab immobilization, traction (skin, gravity or skeletal) and bag of bones technique were associated with high rate of complications like mal-union, stiffness and osteoarthritis of elbow etc.

These fractures are difficult to treat even to an experience surgeon because of its complex anatomy, small area for fixation, articular comminution, limited amount of subchondral bone, fragile articular cartilage and neurovascular architecture adjacent to joint. The goal of treatment is to achieve anatomical reconstruction of articular surface and high mechanical stability allow early rehabilitation, painless and satisfactory elbow function.[4-6]

In recent days with better understanding of fracture anatomy and evolution of implants majority of current recommendations in the management of distal humeral

fractures include open reduction and internal fixation (ORIF) with plates and screws. ORIF of the fracture allows the surgeon to restore anatomical alignment of the fracture fragments and permit early range of motion (ROM) exercises which may aid in the return of a functional ROM of the elbow postoperatively. Various forms of internal fixation have been evolved over time in an attempt to best restore anatomical alignment of the distal humerus.[7,8]

Most authors currently recommending at least two plates be utilized to provide adequate stability and allow for adequate restoration of anatomy. However, the position of plate remains controversial regarding terms of providing optimal stability. The outcomes of available biomechanical studies are completely different and are even contradicting.[9]

The purpose of this study is to compare functional and radiological outcomes and complications in patients with type C intra-articular distal humeral fractures using perpendicular and parallel plating methods.

METHODS

Between June 2019 to Jan 2021, total 34 patients with distal humerus fracture type C were treated using open reduction and internal fixation using dual plate osteosynthesis technique in government medical college and hospital Nagpur. Patients were randomly divided into two groups, one undergoing perpendicular plating with 17 patients and the other parallel plating with 17 patients. Patients were followed up minimally for 12 months.

Study type was randomised control trial.

Inclusion criteria

Distal humeral fractures classified as type C according to the association for osteosynthesis/ association for the Study of internal fixation (AO/ASIF) classification system, and a minimum follow-up after surgery of 12 months were included in the study

Exclusion criteria

suspicion of primary or metastatic tumours with a pathological fracture and, age below 18 and above 60 years were excluded.

Intervention-Group1: patients treated perpendicular plating. Group2: patients treated with parallel plating.

Surgical technique

The patient, were given a general anaesthesia or regional anaesthesia and were positioned in the lateral position, with the involved limb supported over bolsters in OT table.

The midline posterior skin incision was taken beginning approximately 5 cm distal to the tip of the olecranon and extending proximally midline of the arm approximately 8 cm above the tip of the olecranon with lateral curve over olecranon tip.[10]

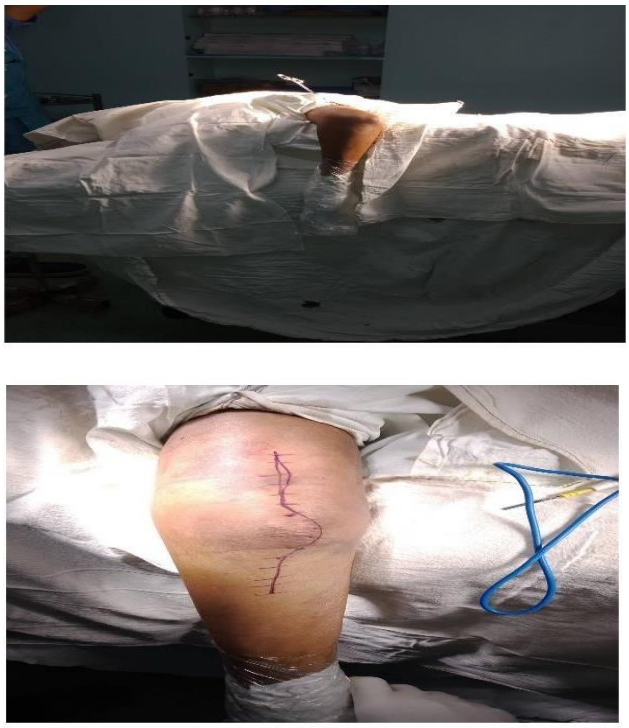

Figure 1: Position and skin marking.

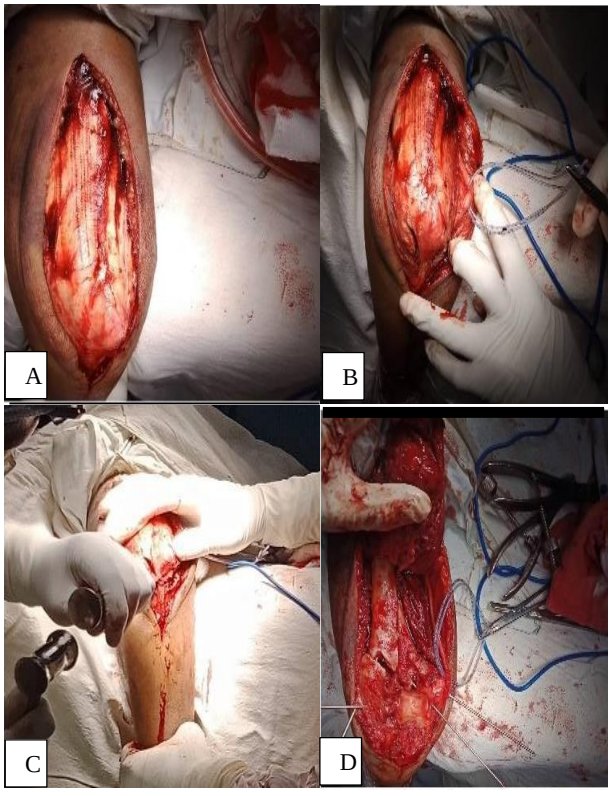

Figure 2 (A-D): Intra-operative images, skin incision, ulnar nerve retraction, olecranon osteotomy and temporary fixation with K wires.

The ulnar nerve is isolated and fascia over the flexor carpi ulnaris is longitudinally split over 5cm to enhance the nerve mobility. Then gently retracted from its bed with a moist tape. An intra-articular olecranon osteotomy was made in a shallow V or Chevron fashion in the centre of the olecranon sulcus that is approximately 2cm from the tip of the olecranon. Osteotomy created with thin bladed oscillating saw or multiple holes were made with 2.7mm drill bit and completed with a thin bladed osteotome. Condyles were reduced and held with a bone holding clamp. Reduced condyle was provisionally fixed with Kirschner wire. Reduction and fixation of the condyles to metaphysis. Reduction and temporary stabilization of the medial and lateral columns was done by using crossed Kirschner wire. Medial and lateral pillars were reconstructed using 3.5mm reconstruction plate or 3.5mm anatomical plates with screws as feasible. Decision about position of plate was taken pre operatively according to randomization table.

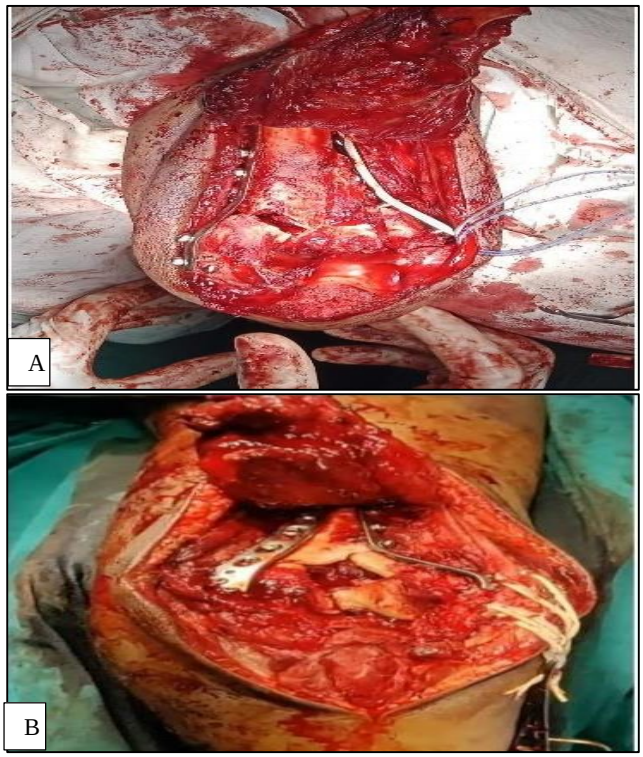

Figure 3 (A and B): Position of plates-parallel plating and orthogonal plating.

Parallel plates placed one on medial column and second on lateral column 180 degree to each other in coronal plane. Perpendicular placed on one medial column similar to parallel plating and the second was placed on lateral column posteriorly, 90 degrees to each other in coronal plane. The stability of the internal fixation was tested by putting the elbow through a range of motion. The olecranon osteotomy was reduced under direct vision and held with reduction clamp. Two k wire parallel to each other was introduced from the tip of the olecranon placed obliquely.

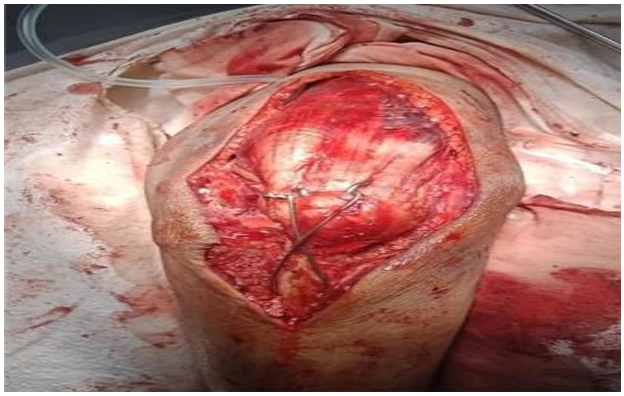

Figure 4: Closure of olecranon osteotomy.

At the completion of the fixation the elbow was again put through a range of motion to test the security of the internal fixation. Haemostasis achieved and wound was close in layers. Pressure bandage was applied and limb immobilized with above elbow POP slab.

Patients were instructed to keep the limb elevated. Suction drain was removed after 48 hours. Wound was inspected after 4 days postoperatively. Intra venous Antibiotics and analgesics were given till 3 days and then shifted to oral antibiotics and analgesics till the time of suture removal. A full range of flexion extension exercises were initiated one time per day, 3 days after the operation. Elbow flexion was evoked by gravity force and then active extension was completed under the protection of the uninjured side. Rotation motion of the forearm was also performed. In the interval between exercises, a long arm cast was placed with the elbow in 90° of flexion for 3 weeks, after which active motion was started.

Follow up and assessments

After discharge, patients advised to follow up after 3 weeks and 6 weeks and thereafter 3 months. The results were assessed 3 and 6 months after the procedure. At follow up a detailed clinical examination was done and patients were assessed subjectively for the symptoms like pain, swelling and restriction of joint motion.

The functional assessment of the patient was done according to-Mayo elbow performance score.

Data collection and analysis- the data was collected with the help of standard, pre-validated, semi-structured case record proforma. The collected data was entered with the help of Microsoft excel spreadsheets and analyzed by using SPSS.

Ethical approval was taken.

RESULTS

The 21 patients were male and 13 were female. Mean age of patients was 41.09 years. 20 patients were right sided

and 14 were left side. The mean intraoperative blood loss in parallel plating was 194.12 ml and it was 203.53 ml in perpendicular plating. There was no significant difference in blood loss in between both methods. The mean surgery time for parallel plating was 117.94 min and which was 119.71 min in orthogonal plating. There was no significant difference in duration of surgery. We observed that time of union for parallel plating method was 12.82 weeks and 12 weeks in orthogonal plating. In our study functional outcome based upon Mayo elbow performance Score, in group 1 (Parallel plating) was excellent in 7 patients (41.17%), good in 6 patients (35.29%), fair in 4 patients (23.52%). We didn't find any poor outcome patient in parallel plating. In our study functional outcome based upon Mayo Elbow performance score in group 2 (Orthogonal plating) was excellent in 11 patients (64.70%), good in 4 patients (23.52%), fair in 1 patient (5.88%) and poor in 1 (5.88%) patient. the average MEPS score at the end of 6 month was slightly superior for orthogonal plating technique patients (89.12; good to excellent) compared to parallel plating technique patients (85.88; good). There was no significant difference. Arc of motion in parallel plating was 107.65 and that of in Perpendicular plating was 110 degrees. In our study, we had counter with complications like infection, wound dehiscence, ulnar neuropathy, palpable hardware, and heterotrophic ossification. The complication rate was slightly higher in patients operated with parallel plating. We didn't find any patient with hardware failure.

Table 1: Age wise distribution.

Age (years)	N	Percentage (%)
18-40	20	58.8
41-50	4	11.8
51-60	6	17.6
61 and above	4	11.8
Total	34	

Table 2: Sex wise distribution.

Sex	N	Percentage (%)
Male	21	61.8
Female	13	38.2
Total	34	

Table 3: Side wise distribution.

Side	N	Percentage (%)
Left	20	58.8
Right	14	41.2
Total	34	

Table 4: Mode of injury.

Mode of injury	Male	Female
Road traffic injury	13	9
Simple fall	3	4
Fall from height	3	0
Assault	2	0

Table 5: MEPS score comparison at 6 months.

Procedure	MEPS score		P value (t-test)
	Mean	S. D.	
Parallel plating	85.88	11.624	0.406
Orthogonal plating	89.12	10.787	

Table 6: Comparison of arc of motion at 6 months.

Procedure	Arc of motion		P value (t-test)
	Mean	S. D.	
Parallel plating	107.65	23.593	0.771
Orthogonal plating	110.00	23.117	

Case illustration

Figure 5 (A and B): Pre and post operative radiographs. Parallel plating and orthogonal plating.

Figure 6 (A and B): Clinical outcome at 6 months-parallel plating and orthogonal plating.

DISCUSSION

Fractures of the distal humerus represent approximately 2%-6% of all fractures and 30% of all elbow fractures, intra articular distal humerus fracture are rare accounting 0.5% of all fractures. In our study we treated 34 patients of distal humerus fracture. Patients were allotted according to randomization table. Group 1 (17 patients) Treated with orthogonal plating and group 2 (17 patients) Treated with parallel plating. Adult Patients above the age of 18 years were included after taking informed written consent. Open reduction and internal fixation with Double plate osteosynthesis is the standard treatment for intra-articular fractures of the distal humerus.[11] Controversy between lateral column plate placement methods, direct lateral or poster lateral continues. The AO (Association for the study of internal fixation) group recommended orthogonal plating in distal humerus fractures, whereas O'Driscoll et al.[12] Recommended osteosynthesis with parallel plates. In comparing to study by Sanchez-Sotelo et al (13), here majority of distal humerus from road traffic accidents and others fall from height. Since females travel less in our society high male: female ratio seen in our study (2:1) as compared to 1:1 recorded by Sanchez-Sotelo et al.[13] In our study, there were 21 (61.8%) males and 13 (38.2%) females comparable to study by Henley et al and in Wang et al studies showed 60% males and 40% females.[14,15] The17 cases in our study were operated with parallel plating which provides absolute stability for early mobilisation. The lateral plate placement directly on the lateral column allows for lengthy screw placement which is limited in traditional orthogonal plating due the fear anterior capitellar breach in the same. In our study we have not met any implant failures or non-union at the fracture site which is on par with the fact that parallel plating offers an inherently stable construct in each clinical situation and in concurrence with studies done on parallel plating by Sanchez-Sotelo et al and Atalar et al.[13,16] Similarly, in our study, 17 patients were operated with orthogonal plating. The lateral plate placement directed posterolaterally on lateral column. Even though various biomechanical studies suggest superiority of parallel plating in terms of stability we did not meet any implant failures or non-union at the fracture site in orthogonal plating, similar results were obtained to Shaik, Venugopala Reddy et al.[17]

The mean surgical time in parallel plating was 117 min and the mean blood loss was 194 ml. The mean surgical time in orthogonal plating was 119 min and mean blood loss was 203 ml. There was no significant difference between surgical time and blood loss in two groups. Similarly Lee et al also didn't observed any significant difference between surgical time and blood loss between parallel plating and orthogonal plating technique.[18] In our study, mean union time for parallel plating was 13 weeks which was slightly higher than for that of perpendicular plating 12 weeks. The t value was 0.494. Kushwah et al reported mean union time for parallel plating was 8.9 weeks and that for parallel plating 9.5 weeks.[19] No significant difference was observed in union time in both the studies.

Complications arose regardless which plating method used. The complications included infection, wound dehiscence, ulnar neuropathy, palpable hardware, heterotrophic ossifications. Sanchez-Sotelo et al describes complication rates of 43% which included wound-healing complications (6%), deep infection (3%), non-union (3%), heterotopic ossification (16%), osteonecrosis 1 (3%), posttraumatic arthritis 2 (6%) permanent ulnar neuropathy (6%).[13] Gofton et al reported a complication rate of 48%, which included heterotopic ossification (17%), olecranon non-union (9%), and infection (9%).[20] Atalar et al showed a complication rate of 48% in their study group of 21 patients.[16] In the recently published retrospective series of Athwal et al assessing the Mayo Elbow parallel plate technique, they noted a complication rate of 53 percent, with complications arising in 17 of 32 patients.[21] The most common complication noted was postoperative nerve injuries (16%), wound complications (12%) including two wound dehiscence's requiring surgical debridement. One olecranon non-union was noted which was treated non-operatively. We observed similar complication rate in our study, which is concurrent with the international literature

which included infection (14.7%), wound dehiscence (14.7), ulnar neuropath (14.7), heterotopic ossification (5.9%), hardware prominence (17.6%). Five patients developed superficial infection (parallel-3, orthogonal-2) which responded to appropriate antibiotics.

Five patients reported wound dehiscence (parallel-3, orthogonal-2) out of which 2 needed secondary suturing and 1 needed soft tissue coverage. 5 patients developed ulnar neuropathy (parallel-3, orthogonal-2) which was for short time and no patient landed up in permanent ulnar nerve dysfunction. 2 patients developed heterotrophic ossification (parallel -1, orthogonal-1) 5 patients developed superficial infection (parallel-3, orthogonal-2) which responded to appropriate antibiotics. 5 patients reported wound dehiscence (parallel-3, orthogonal-2) out of which 2 needed secondary suturing and 1 needed soft tissue coverage. 5 patients developed ulnar neuropathy (parallel-3, orthogonal-2) which was for short time and no patient landed up in permanent ulnar nerve dysfunction. 2 patients developed heterotrophic ossification (parallel -1, orthogonal-1). In our study palpable hardware were significantly higher in parallel plating patients, (t-value; palpable hardware-0.368). Sahoo et al also reported similar complications in their study.[22]

Functional outcome was assessed using the Mayo Elbow performance score, it was excellent in 7 cases, good in 6 case, fair in4 cases with no poor cases, for parallel plating group. For orthogonal plating group the functional outcome was excellent in 11 cases, good in 4 cases, fair in 1 and poor in 1 case. The average Mayo elbow performance Score for parallel plating group was 85.88 which was good and for orthogonal group was 89.12 which was good to excellent. Our results of the parallel plating technique were very similar to Xia et al study, who also found MEPS of 86.1% in a series of 21 patients treated with parallel plating.[23] According to Shin et al study the average mayo elbow performance score was 91.5 in the group of patients (n=17) treated with orthogonal plating technique.[24] In our study the mean arc of motion at the end of 6 month for parallel plating was 107.65 and for orthogonal plating it was 110. P value (t test)=0.771. There was no significant difference arc of motion between parallel plating and orthogonal plating. Xia et al also reported no significant difference in arc of motion between parallel plating and orthogonal plating.[23]

CONCLUSION

Higher incidence of motor vehicle accidents is causing an increasing number of complex distal humerus fractures among younger. A better functional outcome is achieved by an early post operative rehabilitation which is achieved by an absolute stability system. In terms of arc of motion and stability a good to excellent functional outcome was achieved in >85% of the study group. In cases of osteoporotic and comminuted bones, a rigid construct must be achieved. Application of orthogonal plating and parallel plating according to the AO principles is an excellent method for internal fixation of these complicated fractures. Orthogonal plating provides no difference outcome compared to the parallel plating. In conclusion, distal humerus fractures with intraarticular extension treated with a parallel configuration have no advantage over the orthogonal plating except hardware prominence. However long terms follow up and a larger sample study is needed.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Palvanen M, Kannus P, Niemi S, Parkkari J. Secular trends in the osteoporotic fractures of the distal humerus. Eur J Epidemiol. 1998;14(2):159-64.
2. Robinson CM, Hill RM, Jacobs N, Dall G. Adult distal humeral metaphyseal fractures: epidemiology and results of treatment. J Orthop Trauma. 2003;17(1):38-47.
3. Aravindan S. Comparison of Outcome of Management of Distal Humerus Fractures by Orthogonal Plating and Parallel Plating (Doctoral dissertation, Government Mohan Kumaramangalam Medical College, Salem). 2020.
4. Letch R, Schmit-Neuerburg KP, Stürmer KM, WALZ M. Intraarticular fractures of the distal humerus: surgical treatments and results. Clin Orthop Rel Res. 1989(241):238-44.
5. Pollock JW, Faber KJ, Athwal GS. Distal humerus fractures. Orthop Clin N Am. 2008;39(2):187-200.
6. Gabel GT, Hanson G, Bennett JB, Noble PC, Tullos HS. Intraarticular fractures of the distal humerus in the adult. Clin Orthop Rel Res. 1987(216):99-108.
7. John H, Rosso R, Neff U, Bodoky A, Regazzoni P, Harder F. Operative treatment of distal humeral fractures in the elderly. J Bone Joint Surg Bri. 1994;76(5):793-6.
8. Gofton WT, MacDermid JC, Patterson SD, Faber KJ, King GJ. Functional outcome of AO type C distal humeral fractures. J Hand Surg. 2003;28(2):294-308.
9. McKee M, Jupiter J, Toh CL, Wilson L, Colton C, Karras KK. Reconstruction after malunion and nonunion of intra-articular fractures of the distal humerus. Methods and results in 13 adults. J Bone Joint Surg. 1994;7(4):614-21.
10. Dowdy PA, Bain GI, King GJ, Patterson SD. The midline posterior elbow incision. An anatomical appraisal. J Bone Joint Surg. 1995;77(5):696-9.
11. Ring D, Jupiter JB. Fractures of the distal humerus. Orthop Clin N Am. 2000;31(1):103-13.
12. O'Driscoll SW. Optimizing stability in distal humeral fracture fixation. J Shoulder Elbow Surg. 2005;14(1):S186-94.
13. Sanchez-Sotelo J, Torchia ME, O'Driscoll SW. Complex distal humeral fractures: internal fixation with a principle-based parallel-plate technique. JBJS. 2007;89(5):961-9.

14. Henley MB. Intra-articular distal humeral fractures in adults. Orthop Clin N Ama. 1987;18(1):11-23.
15. Wang X, Liu G. A comparison between perpendicular and parallel plating methods for distal humerus fractures: A meta-analysis of randomized controlled trials. Medicine. 2020;99(23).
16. Atalar AC, Demirhan M, Salduz A, Kilicoglu O, Seyahi A. Functional results of the parallel-plate technique for complex distal humerus fractures. Acta Orthop Traumatol Turc. 2009;43(1):21-7.
17. Shaik RB, Reddy VP, Naidu AK. Study of clinical outcome in intra articular distal humerus fractures treated with dual plating. Int J Res Med Sci. 2017;5(6):2438-41.
18. Lee SK, Kim KJ, Park KH, Choy WS. A comparison between orthogonal and parallel plating methods for distal humerus fractures: a prospective randomized trial. Eur J Orthop Surg Traumatol. 2014;24(7):1123-31.
19. Kushwah K, Kelkar R, Rajput DS. A prospective study to evaluate the functional outcome in intra-articular distal humerus fractures treated by dual plating. IJOS. 2022;8(1):500-8.
20. Gofton WT, MacDermid JC, Patterson SD, Faber KJ, King GJ. Functional outcome of AO type C distal humeral fractures. J Hand Surg. 2003;28(2):294-308.
21. Athwal GS, Hoxie SC, Rispoli DM, Steinmann SP. Precontoured parallel plate fixation of AO/OTA type C distal humerus fractures. J Orthop Trauma. 2009;23(8):575-80.
22. Sahoo SS, Singh S, Bansal H, Mandot U, Mishra AK. Comparission Of Functional Results Between Parallel and Orthogonal Plating In The Management Of Distal Humerus Fracture (Ao Type–C). J Dental Med Sci. 2018;17(11):80-6.
23. Xia LA, Zhang LH, Sheng TA, Zhang Q, Liang XD, Yuan BT et al. Comparative study of perpendicular versus parallel double plating methods for type C distal humeral fractures. Chin Med J. 2013;126(12):2337-42.
24. Shin SJ, Sohn HS, Do NH. A clinical comparison of two different double plating methods for intraarticular distal humerus fractures. J Shoulder Elbow Surg. 2010;19(1):2-9.

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