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Functional Results of Intercondylar Fractures of the Humerus Fixed with Dual Y-Plate; A Technical Note

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ABSTRACT

Objective: To evaluate and report the functional results of surgical management of intercondylar fractures of the humerus in adults using a novel dual plating technique.
Methods: A total number of 60 patients with Riseborough and Radin type II, III, and IV intercondylar humerus fractures were operated with open reduction through a Trans-olecranon approach and internal fixation using two plates in inverted-Y configuration. Patients were followed for 3 weeks, 3 months and 6 months and were evaluated using the Mayo Elbow performance score and Quick-DASH Score.
Results: There were 50 (83.33%) men and 10 (16.67%)women with mean age of 34.9±12.63 years. 63.3% of the cases were following Motor vehicle accident and rest following fall. The right upper limb was more commonly affected than the left side. Riseborough and Radin type II fractures accounted for 3.33% of cases; type III fractures accounted for 50% of cases and type IV accounted for 46.67%. Excellent to Good results were seen in almost 80% of cases as per the Mayo Elbow performance score at 6-month follow-up. Quick-DASH scores for the series at 6-month follow-up was on average of 15.96±9.92.
Conclusion: Dual plating in inverted Y configuration offers a reliable fixation, which permits early mobilization and good functional outcome.

Keywords: Intercondylar fracture; Distal humerus; Double plate; Internal fixation..

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Introduction

Distal Humerus intercondylar fractures account for 2% of all adult fractures. These injuries account for 30% of fractures around the elbow in adults [1]. These fractures occur following high energy trauma and require anatomic articular reduction and rigid internal fixation, so that early mobilization can be started, which in turn gives better functional outcomes [2, 3]. The complex architecture of the elbow joint, the adjacent neurovascular arrangement, minimal soft tissue coverage and limited sub-chondral bone makes this injury difficult to treat [4, 5]. Apart from the articular incongruity, other factors which contribute to unsatisfactory outcome include capsular contracture, myositis ossificans

and arthrofibrosis [6]. Open reduction with internal fixation using two plates providing bicolumnar stabilization has been a proven method of treatment with excellent clinical outcomes. There are multiple schools of practice regarding plate placement. The commonly used dual plating technique includes perpendicular plating, parallel plating, and Y plating. In Y plating, two plates are placed on the posterior surface of medial and lateral supracondylar ridges in the coronal plane [7-9]. There are numerous studies comparing and analyzing perpendicular plating and parallel plating but very few studies on outcomes of Y plating using two plates. The purpose of the present study was to evaluate the clinical outcome of inverted Y-shaped double-plating in adults with intercondylar fractures of the distal humerus.

Materials and Methods

Study Population

This was a prospective interventional study being conducted at Mahatma Gandhi Medical College and research Institute, Pondicherry, a high volume tertiary care setup in southern India. All cases with intercondylar humerus fracture presenting to our outpatient and emergency from January 2013 to July 2015, who fulfilled the inclusion criteria, were included in this study. The inclusion criteria included all patients from 18 years to 60 years with intra-articular distal humerus fractures as per Riseborough and Radin classification (Type I-IV). The exclusion criteria were other fractures in the same limb, paralytic limb, previous deformity or stiffness in the ipsilateral upper limb, open fractures, previous surgeries to the same elbow, patients with head injury and patients with polytrauma. The study protocol was approved by the institutional review board (IRB) and the medical ethics committee of Mahatma Gandhi Medical College and Research institute. All the patients provided their informed written consents before inclusion in the study. Preoperative CT scan with 3D reconstruction was done for identification of fragments.

Surgical Technique

Surgery was performed under regional anesthesia and tourniquet control. Open reduction using posterior approach to elbow with chevron osteotomy was performed. The ulnar nerve was protected. Articular reconstruction was done and provisionally stabilized with 'K' wires. Final fixation with an intercondylar screw and 3.5mm reconstruction plates placed in inverted Y configuration was done. Intra-operatively the joint was put through a passive full range of movement and stability was checked. Anterior transposition of the ulnar nerve was done routinely in all cases. The Olecranon osteotomy was then reduced under direct vision and fixed by tension band wiring or 6.5 mm cannulated cancellous screw. In the postoperative period, limb elevation was maintained. Wound inspection was done on post-operative day two and five and suture removal on twelfth postoperative day.

Follow-Up and Outcome Measurement

Active mobilization was started on the first postoperative day in the form of flexion-extension and pronation-supination exercises. Follow-up was done at 6 weeks, 3 and 6 months in an outpatient clinic. A detailed clinical examination including range of motion, pain at fracture site and elbow stability was performed in each visit. Further radiographs were taken and assessed for union, pre-post angulation and position of the plates and screws. Mayo Elbow Performance Index was calculated at each visit [10]. Quick-DASH scoring was also done at 6-month follow-up.

Statistical Analysis

All the statistical analysis was performed using statistical package for social sciences (SPSS Inc. Chicago, Illinois, USA) version 16. Data are presented as mean±SD and proportions as appropriate. Non-parametric data was compared using chi-square test while independent t-test was used to compare the parametric variables. A 2-sided p-value of less than 0.05 was considered statistically significant.

Results

Our total sample size was 60. In our series 10 patients (16.66 %) were below 20 years, 18 patients (30%) were between 21 to 30 years, 12 patients (20%) were between 31 to 40 years, 12 patients (20%) were between 41 to 50 years, and 8 patients (13.33%) were between 51 to 60 years (Table 1, Figure 1A). The mean age of presentation was 34.9 years±12.63.

Table 1. Baseline characteristics of patients

Variable	Value
Age (Years)	34.9 ± 12.63
<20 (%)	10 (16.6%)
21-30 (%)	18 (30%)
31-40 (%)	12 (20%)
41-50 (%)	12 (20%)
51-60 (%)	8 (13.33%)
Gender Distribution	
Male (%)	50 (83.33%)
Female (%)	10 (16.67%)
Mechanism of Injury	
Motor Vehicle Accident (%)	38 (63.33%)
Fall (%)	22 (37.67%)
Side Involvement	
Right (%)	31 (51.67%)
Left (%)	29 (48.33%)
Fracture Classification	
Type II (%)	2 (3.33%)
Type III (%)	30 (50%)
Type IV (%)	28 (46.67%)

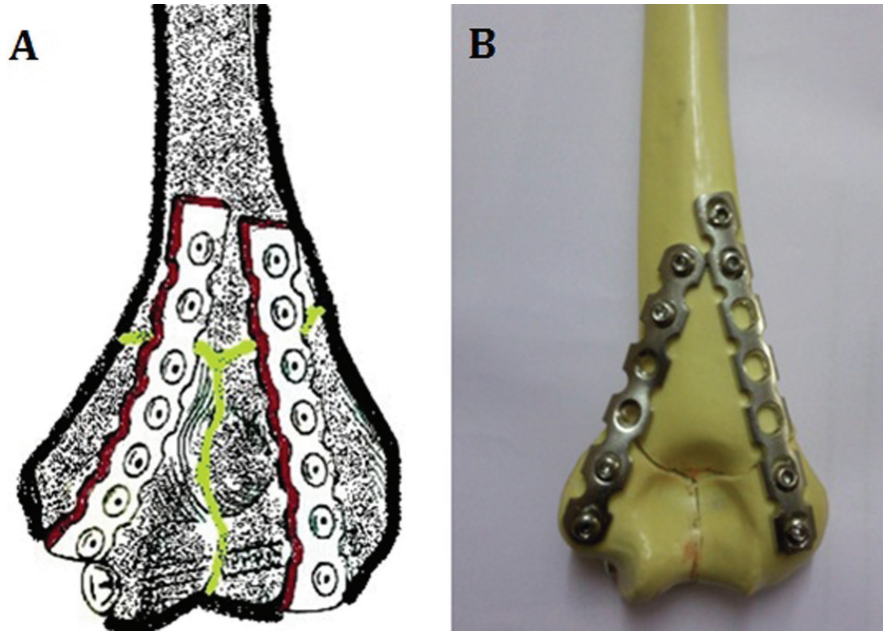

Fig. 1. The dual Y-plate fixation: Schematic view (A) and bone model (B).

Fifty patients (83.33%) in our series were males, and ten patients (16.67%) were females (Table 1). The mechanism of injury was found to be motor vehicle accident in 38 cases (63.33%) and fall at home in 22 cases (36.67%) (Table 1). The association of mode of injury with gender was statistically significant with a p value of 0.0286. All the patients in our series were right-hand dominant. Right upper limb involvement was seen in 32 patients (53.33%) and left upper limb in 28 cases (46.67%) (Table 1, Figure 1B). As per the Riseborough and Radin classification, there were no type I fractures, Type II in 2 patients (3.33%), Type III in 30 patients (50%) and type IV in 28 patients (46.67%) (Table 1, Figure 2A). The association of mechanism of injury to the severity of fracture as per Riseborough and Radin classification was statistically significant with *p* value of 0.022981. All fractures in our series achieved solid union by six months. Mayo Elbow performance score at final (6th month) follow-up was excellent (>90) in 8 patients (13.33%), good (75-89) in 40 patients (66.67%), fair (60-74) in 8 patients (13.33%) and poor (<60) in 4 patients (6.67%). Mean Mayo elbow performance score (MEPS) was 80.08±10.15 at 6-month follow-up (Table 2). The mean MEPS at 6th week and 12th-week follow-up were 57.42±6.86 and 70.58 ± 8.59 respectively. The difference of means of Mayo score at 6 weeks, 12 weeks and 6 months was statistically significant *(p*<0.001) (Table 2, Figure 2B). The mean Quick-DASH score at 6-month follow-up was 15.96±9.92. Only four minor complications were reported, two cases of superficial infection and two cases of ulnar nerve neuropraxia (Table 2). All four improved with conservative treatment. There were

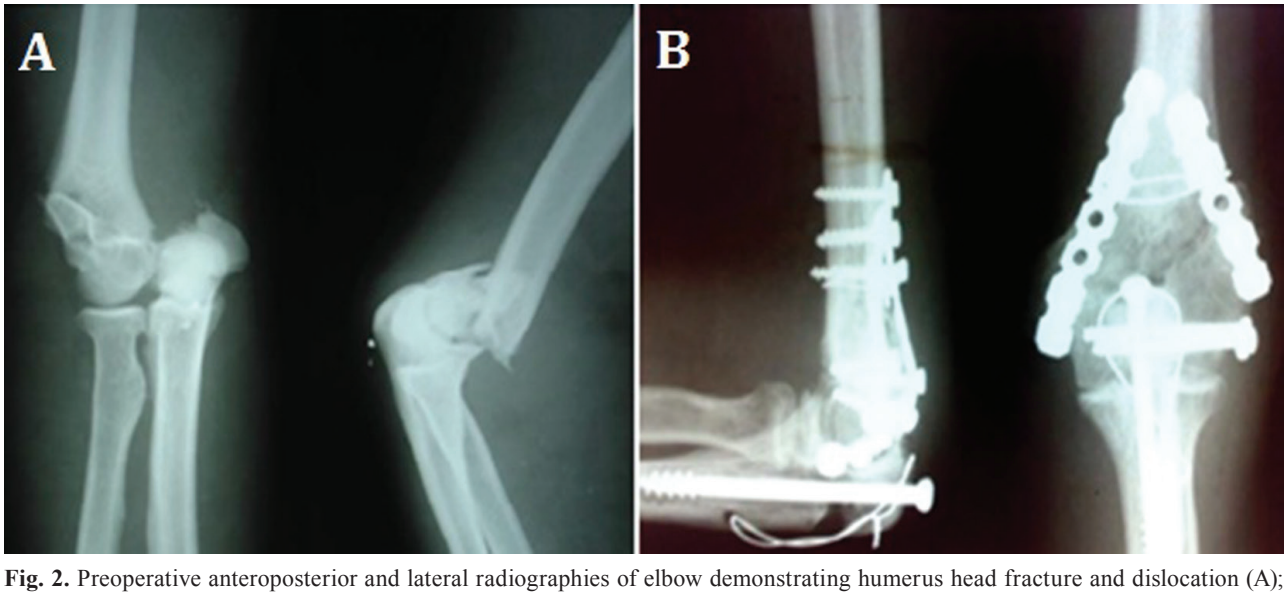

Fig. 2. Preoperative anteroposterior and lateral radiographies of elbow demonstrating humerus head fracture and dislocation (A); postoperative anteroposterior and lateral radiographies of the elbow demonstrating successful reduction of the fracture utilizing the dual Y-plate technique.

Table 2. Results

MEPS AT 6 Months		
Meps Grade	**Number of Cases**	**Percentage (%)**
Excellent (>90)	8	13.33
Good (75-89)	40	66.67
Fair (60-74)	8	13.33
Poor (<60)	4	6.67
Mean Meps at 6 Months Follow-up: 80.08±10.15		
Comparison of Change in Mayo Score		
Time Interval	**Change in Meps**	**Two Tailed *P* Value**
6 Weeks- 12 Weeks	13.13±1.74	<0.0001
6 Weeks – 6 Months	22.66±3.29	<0.0001
12 Weeks – 6 Months	9.5±1.56	<0.0001
Unpaired T test-The two-tailed *p* value is <0.0001. By conventional criteria, this difference is considered to be extremely statistically significant.		
Complications		
Superficial infection	2	
Ulnar Nerve Neuropraxia	2	

no major complications.

Discussion

In recent years, a two-column anatomical concept of the distal humerus has been followed, as per which the distal humerus is considered to be a triangle, with the coronoid fossa and olecranon fossa occupying the central area and the medial and lateral condyles forming two strong columns [11, 12]. Fixation of the distal humerus must restore not only the elbow joint congruity but also stabilize the medial and lateral columns. In spite of controversies concerning the appropriate treatment of Intercondylar humerus fractures, double plate fixation has been proved to produce satisfactory clinical results. However, controversies still exist regarding the best site of plate placement during dual plate fixation. A biomechanical study regarding the stability provided by parallel, perpendicular and Y plating was done by Srecko Sabalic *et al*., [13] in 2013 in extraarticular distal humerus fractures. They proved that in all the three models, the displacements occurring with stress were minimal and within the range that allowed union. Numerous studies including studies by Shin SJ *et al*., [14] and Arnander MW *et al*., [15] have compared outcomes of parallel and 90-90 plating systems for distal humerus fractures. There are no present studies with a systematic review of posterior Y plating.

The average age of patients in our study was 34.9 years±12.63 with maximum population in the 2nd decade. This was comparable to study by Liu D et al. where mean age was 39 years [16]. In our study, there were 83 percent males and 17 percent females contrary to studies by Liu D et al. and Ozer H et al. where there were 57 and 55 percent males and 43 and 45 percent females' respectively [16, 17]. This difference in sex distribution may be due higher incidence of motor vehicle accidents among males in our region. Observations regarding mechanism of injury, side involvement, and fracture classification were similar and comparable to studies by Henley MB *et al*., [16] and Liu D *et al*., [18]. All the fractures in our study achieved bony union by six months. There was no delayed union or nonunion. Most authors including Lee SK *et al*., [19] Leigey DF *et al*., [20] and many others have similar observation in their studies, with no nonunion or delayed union.

The postoperative Mayo Elbow performance score was 80.08±10.15. This was comparable to most studies including Sanchez-Sotelo *et al*., [9] (mean MEPS-85), Athwal *et al*., [21] (mean MEPS-82) and Atalar *et al*., [22] (mean MEPS-86.1) where parallel plate fixation was done and also Tian *et al*., [23] (mean MEPS-89.6) and Lan *et al*., [24] (mean MEPS-85). Where dual perpendicular plate fixation was used. Only two studies by Rebuzzi *et al*., [25] (mean MEPS-94.17) and Sanjiv Kumar *et al*., [26] (mean MEPS-96.32) had MEPS of greater than 90 following operative fixation. This may be attributed to the lower average age group of the study population in these studies. A further functional evaluation was also done using the Quick-DASH score. Our mean score of 15.96±9.92 suggested a good outcome. Quick DASH score as a criterion for functional assessment in elbow injury has not been used in any study till date and hence could not be compared.

The post-operative complication rates vary from 6 to 44 percent in various studies. Our study had minimal complications. The technical advantages of this procedure include a lower incidence of ulnar nerve palsy which may be due to our routine practice of anterior transposition of the nerve. The lower incidence of superficial infection and absence of deep infection may be explained by the decreased surgical time due to minimal soft tissue dissection and minimal periosteal stripping. The application of both plates on the posterior aspect instead of on the ridges results in a stable fixation requiring

lesser soft tissue dissection and minimal ulnar nerve retraction with decreased operative time and lesser complications. Gupta *et al*., [27] had derived a similar conclusion from their study. Due to minimal soft tissue and periosteal stripping it was difficult to maintain reduction using reduction clamps. So it is advisable to provisional fix the fracture fragments with K wires for maintaining reduction and ease of plate application. Limitations of our study included smaller sample size, shorter follow-up and lack of comparison group.

In conclusion, treatment of intercondylar humerus fractures with Dual Y plate fixation is an effective method which permits early mobilization and has a good functional outcome with minimal complications. This may in future become the preferred method of fixation by most surgeons.

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Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. (In case humans are involved) Informed consent: Informed consent was obtained from all individual participants included in the study.

Conflict of Interest: None declared.

References

1. Korner J, Lill H, Muller LP, Rommens PM, Schneider E, Linke B. The LCP-concept in the operative treatment of distal humerus fractures--biological, biomechanical and surgical aspects. *Injury*. 2003;**34** Suppl 2:B20-30.
2. Coles CP, Barei DP, Nork SE, Taitsman LA, Hanel DP, Bradford Henley M. The olecranon osteotomy: a six-year experience in the treatment of intraarticular fractures of the distal humerus. *J Orthop Trauma*. 2006;**20**(3):164-71.
3. Chen G, Liao Q, Luo W, Li K, Zhao Y, Zhong D. Triceps-sparing versus olecranon osteotomy for ORIF: analysis of 67 cases of intercondylar fractures of the distal humerus. *Injury*. 2011;**42**(4):366-70.
4. Cannada L, Loeffler B, Zadnik MB, Eglseder AW. Treatment of high-energy supracondylar/intercondylar fractures of the distal humerus. *J Surg Orthop Adv*. 2011;**20**(4):230-5.
5. Schmidt-Horlohe K, Wilde P, Bonk A, Becker L, Hoffmann R. One-third tubular-hook-plate osteosynthesis for olecranon osteotomies in distal humerus type-C fractures: a preliminary report of results and complications. *Injury*. 2012;**43**(3):295-300.
6. Modabber MR, Jupiter JB. Reconstruction for post-traumatic conditions of the elbow joint. *J Bone Joint Surg Am*. 1995;**77**(9):1431-46.
7. Doornberg JN, van Duijn PJ, Linzel D, Ring DC, Zurakowski D, Marti RK, et al. Surgical treatment of intra-articular fractures of the distal part of the humerus. Functional outcome after twelve to thirty years. *J Bone Joint Surg Am*. 2007;**89**(7):1524-32.
8. Luegmair M, Timofiev E, Chirpaz-Cerbat JM. Surgical treatment of AO type C distal humeral fractures: internal fixation with a Y-shaped reconstruction (Lambda) plate. *J Shoulder Elbow Surg*. 2008;**17**(1):113-20.
9. Sanchez-Sotelo J, Torchia ME, O'Driscoll SW. Complex distal humeral fractures: internal fixation with a principle-based parallel-plate technique. *J Bone Joint Surg Am*. 2007;**89**(5):961-9.
10. Morrey BF, An KN, Chao EYS. Functional evaluation of the elbow. In: Morrey BF, editor. The Elbow and Its Disorders. 2nd ed. Philadelphia: WB Saunders; 1993. p. 86-89.
11. Li SH, Li ZH, Cai ZD, Zhu YC, Shi YZ, Liou J, et al. Bilateral plate fixation for type C distal humerus fractures: experience at a single institution. *Int Orthop*. 2011;**35**(3):433-8.
12. Reising K, Hauschild O, Strohm PC, Suedkamp NP. Stabilisation of articular fractures of the distal humerus: early experience with a novel perpendicular plate system. *Injury*. 2009;**40**(6):611-7.
13. Sabalic S, Kodvanj J, Pavic A. Comparative study of three models of extra-articular distal humerus fracture osteosynthesis using the finite element method on an osteoporotic computational model. *Injury*. 2013;**44** Suppl 3:S56-61.
14. 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.
15. Arnander MW, Reeves A, MacLeod IA, Pinto TM, Khaleel A. A biomechanical comparison of plate configuration in distal humerus fractures. *J Orthop Trauma*. 2008;**22**(5):332-6.
16. Liu D, Li P. [Treatment of distal humerus fracture with double-plating fixation]. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi*. 2010;**24**(6):680-2.
17. Ozer H, Acar HI, Comert A, Tekdemir I, Elhan A, Turanli S. Course of the innervation supply of medial head of triceps muscle and anconeus muscle at the posterior aspect of humerus (anatomical study). *Arch Orthop Trauma Surg*. 2006;**126**(8):549-53.
18. Henley MB. Intra-articular distal humeral fractures in adults. *Orthop Clin North Am*. 1987;**18**(1):11-23.
19. 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.
20. Leigey DF, Farrell DJ, Siska PA, Tarkin IS. Bicolumnar 90-90 plating of low-energy distal humeral fractures in the elderly patient. *Geriatr Orthop Surg Rehabil*. 2014;**5**(3):122-6.
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. 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.
23. Tian D, Jing J, Qian J, Li J. Comparison of two different double-plate fixation methods with olecranon osteotomy for intercondylar fractures of the distal humeri of young adults. *Exp Ther Med*. 2013;**6**(1):147-51.
24. Lan X, Zhang LH, Tao S, 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 (Engl)*. 2013;**126**(12):2337-42.

25. Rebuzzi E, Vascellari A, Schiavetti S. The use of parallel pre-contoured plates in the treatment of A and C fractures of the distal humerus. *Musculoskelet Surg*. 2010;**94**(1):9-16.

26. Kumar S, Singh S, Kumar D, Kumar N, Verma R. Intercondylar humerus fracture- parallel plating and its results. *J Clin Diagn Res*. 2015;**9**(1):RC01-4.

27. Gupta R, Khanchandani P. Intercondylar fractures of the distal humerus in adults: a critical analysis of 55 cases. *Injury*. 2002;**33**(6):511-5.