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Comparative study between double plating and Y plate in management of intercondylar humeral fracture

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Abstract---Background: Intercondylar humeral fracture is one of the commonest & challenging fractures of young adult and counts for about 30% of all elbow fractures. Aim: Evaluation of two groups of patients, group 1 and group 2 managed by double plates and group B by Y plate Materials and Methods: This Prospective study was conducted on 44 patients, Group 1 22 patient and Group 2 22 patient. The study included patients aged between 16-59 years with intercondylar humeral fracture type C according to AO classification while patients with compound fractures, osteoporotic bone, pathological fractures, and patients aging less than 16 years and more than 59 years were excluded. Follow up at 3 and 6 months. Results: Range of movement after 3 & 6 months was 84±31 and 98±35 respectively in group 1 which was relatively high compared to 48±25 and 71±21 respectively in group 2. MAYO Elbow Performance Score after 3 & 6 months was 71±21 and 82±23 respectively in group 1 which was relatively high compared to 48±14 and 73±12 respectively in group 2. After 3 months of follow up, MEPS grade showed that the majority was good in group 1 representing 54.5% while poor in group 2 representing 76.2% Similarly, the grade after 6 months of follow up was excellent in group 1 representing 45.5% while good in group 2

representing 42.9%. Conclusion: From a clinical and statistical perspective, there is no significant differences were observed between the group 1 and group 2 in terms of union time and complications, however there is high statistical difference between group 1 & group 2 regarding range of motion and Mayo Elbow Performance Score.

Keywords---intercondylar humeral fracture, double plate, Y plate, humerus.

Introduction

Distal humeral fractures gaining its importance from its relation to elbow joint. The elbow is a complex joint in which many neurovascular, tendinous, ligamentous, and osseous structures are lying together. In order to avoid complications, it is important to have a deep knowledge of the anatomy and to be confident with the most commonly used surgical techniques (Barco et al., 2014, Yetter et al., 2021).

The distal humerus is described as lateral and medial columns separated by the trochlea which locate in 4-8 degrees of valgus and 3-8 degrees of external rotation in relation to the longitudinal axis of the humerus. The distal articulating surface is angulated anteriorly by 30 degrees in the lateral plane distally projecting further on its medial aspect (Llusa et al., 2009). The clinical diagnosis is made when patient presents a painful swollen and deformed elbow joint (Sur et al., 2020, Ennis et al., 2008). Vascular injuries are most common in supra and intercondylar fractures. Fractures with signs of ischemia must be treated urgently. Nerve injury occurs in 25% of cases and affects either the ulnar or median nerves (Antuña et al., 2010; Kelany et al., 2020).

Inter condylar humeral fractures represent one of the most complicated and challenging fractures in the upper extremity it accounts for 2% of all fractures in adults (Korner et al., 2003). These fractures occur following high energy trauma and anatomic articular reduction and rigid internal fixation, are required so that early mobilization can be performed, which in turn gives better functional outcomes. The complex anatomy of the elbow joint, together with the adjacent neurovascular supply, minimal covering soft tissue and subchondral bone makes this injury challenging to treat (Cannada et al., 2011, Schmidt-Horlohe et al., 2012). Also, capsular contracture, myositis ossificans and arthrofibrosis may contribute to the unsatisfactory outcomes of these fractures (Mahapatra and Abraham, 2017).

There are numerous schools of practice concerning plate placement for surgical treatment of supracondylar intercondylar humerus fractures using standard approaches (Doornberg et al. (2007). The commonly used dual plating technique includes perpendicular plating, parallel plating, and Y plating (Sanchez-Sotelo et al., 2007; Luegmair et al., 2008). The aim of this study to evaluate patients with intercondylar humeral fracture treated by either double plates or Y plate regarding stable anatomic reduction, range of motion, measuring union time and

rate of complications in both methods. Evaluation of patients was done using Mayo Elbow Performance Score.

Patients and Methods

This prospective study was conducted 44 patients who underwent surgical open reduction and internal fixation and followed up for a minimum of 6 months in the period from April 2015 to February 2017. The study group divided into Group 1 including 22 patients with intercondylar humeral fracture treated by double plates and Group 2 including 22 patients with intercondylar humeral fracture treated by Y plate. This study included patients aged between 16-59 years with intercondylar humeral fracture type C according to AO classification while patients with compound fractures, osteoporotic bone, pathological fractures, and patients aging less than 16 years and more than 59 years were excluded.

All patients in the study group were examined upon entry to ER of the hospital before surgery and 2 weeks, 3 months and 6 months after surgery and the limitations of the elbow movements during daily activities were tested using Mayo Elbow Performance Score (MEPS) In the ER, Patient was resuscitated, above elbow slab was done, neurovascular assessment & full trauma survey were done after that X-ray and CT with 3D reconstruction were achieved. Then, the patients were taken up for surgery after preoperative investigations (CBC, INR, PC, liver enzymes, Urea, Creatinine, viral markers, and ECG) were done.

One unit of blood was saved pre-operatively and a dose of intravenous antibiotic was administered before induction of anesthesia and post operatively during hospital stay then shifted to oral antibiotic on discharge. The patients were positioned on lateral decubitus with affected side upwards with a support under the arm to hold the elbow at 90 degrees flexion and a pneumatic tourniquet was used. The skin was draped with betadine from tips of fingers till just distal to tourniquet. The elbow was exposed through posterior skin incision skirting around olecranon medially. The ulnar nerve was systematically approached & protected. Penetration of the extensor system by triceps sparing technique (4 of group 1 & 3 of group 2), triceps splitting technique (12 of group 1 & 19 of group 2) or by olecranon osteotomy (6 of group 1 & no one of group 2).

Preliminary reduction of the fracture by K wire was performed aiming anatomical reduction of articular surface & reduction of both medial and lateral columns to the humeral shaft. Intra operative fluoroscopy (C arm) was used to ensure anatomical reduction especially to articular surface. Fixation of the fracture was done using Y plate or double plating (using anatomical lateral plate with reconstruction medial plate, two reconstruction plates medial and lateral or reconstruction plate with one third (1/3 tubular plate) using 2.7mm drill pit & 3.5mm screws and fixation of medial & lateral condyles using cannulated screw(4mm).

After fracture reduction and fixation, triceps tendon was repaired by absorbable sutures and if olecranon osteotomy was done, fixation of olecranon was done by tension band wiring or by cannulated screw on washer. Finally, Insertion of

vacuum drain and closure of subcutaneous layer and skin were performed and above elbow resting slab was done.

In the postoperative period, drain was removed at second postoperative day, intravenous antibiotic was given during hospital stay and sutures and posterior above elbow slab were removed on 14th post-operative day. After 2 weeks, controlled assisted active mobilization was done by hinged elbow brace for one month. Physiotherapy was carried out 1 month postoperatively and continued for 1 month. The data was tabulated and statistically analyzed using Statistical Package of Social Science software program, version 23 (IBM SPSS).

Results

This study was conducted on 44 patients, which was divided into two groups according to the management techniques. Distribution of gender was 16 (72.7%) males and 6 (27.3%) females in group 1 and 14 (63.6%) males and 8 (36.4%) females in group 2. Among the study group, 63.6% were smokers in group 1 compared to 54.5% in group 2. Regarding the side of affection, Group 1 included 7 (31.8%) right sided affection while 15 (68.2%) were left sided compared to 11 (50%) right sided affection and 11 (50%) left sided affection in group 2. This affection resulted in comorbidities in 13.6% and 31.8% of group 1 and group 2 respectively. In addition, it was associated with injuries in 36.4% and 40.9% in group 1 and group 2 respectively. Clinically, the fractures were classified as type C according to the Association for Osteosynthesis / Association for the Study of Internal Fixation (AO/ASIF) classification system in which pattern 13c1 was the highest (50.0%) in group 1 compared to pattern 13c3 that was the highest (63.6%) in group 2. The mode of trauma showed a variety between both group; fall from height represented the highest (31.8%) mode in group 1 compared to road traffic accident (59.1%) in group 2.

All patients were examined after surgery using three measures of assessment: union time, range of movement and MEPS. Also, the post-operative complications & the used secondary procedures (if present) were assessed. The average follow-up time was almost equal = 7 ± 1 months in group 1 compared to 7 ± 2 months in group 2. Regarding union time, it was almost equal in both groups represented by 3 ± 2 months in group 1 compared to 3 ± 1 months in group 2. Range of movement after 3 & 6 months was 84 ± 31 and 98 ± 35 respectively in group 1 which was relatively high compared to 48 ± 25 and 71 ± 21 respectively in group 2. MEPS after 3 & 6 months was 71 ± 21 and 82 ± 23 respectively in group 1 which was relatively high compared to 48 ± 14 and 73 ± 12 respectively in group 2 (Table 1).

Table 1: The follow up details for the participants of both groups

	Group 1		Group 2	
	Mean	SD	Mean	SD
Follow up (months)	7 ± 1		7 ± 2	
Union time (months)	3 ± 2		3 ± 1	
Range (3 months)	84 ± 31		48 ± 25	
Range (6 months)	98 ± 35		71 ± 21	
MEPS (3 months)	71 ± 21		48 ± 14	

MEPS (6 months)	82 ± 23	73 ± 12
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After 3 months of follow up, MEPS grade showed that the majority was good in group 1 representing 54.5% while poor in group 2 representing 76.2% while the grade after 6 months of follow up was excellent in group 1 representing 45.5% while good in group 2 representing 42.9% (Table 2).

Table 2: MEPS among both groups after the first 3 & 6 months of follow up

MEPS Grade	Group 1				Group 2			
	3 months		6 months		3 months		6 months	
	N	%	N	%	N	%	N	%
Poor	5	22.7 %	3	13.6 %	16	76.2 %	3	14.3 %
Fair	3	13.6 %	1	4.5 %	4	19 %	7	33.3 %
Good	12	54.5 %	8	36.4 %	1	4.8 %	9	42.9 %
Excellent	2	9.1 %	10	45.5 %	0	0	2	9.5 %
Total	22 (100 %)				22 (100%)			

The statistical analysis regarding relation between assessment measures and the used management procedures showed a high significant difference between Double Plating and Y plate management techniques regarding range of movement in addition to the Mayo Elbow Score after 3 & 6 months of follow up, using Mann-Whitney U test, with p -value <0.05 . However, it showed insignificant difference between management techniques regarding union time, with p -value >0.05 (Table 3).

Table 3: The relation between assessment measures and the used management procedure based on Mann-Whitney U test

Assessment measures	Group 1 N=22		Group 2 N=22		U	Z	p-value
	Mean Rank	Sum of Ranks	Mean Rank	Sum of Ranks			
Union Time (Months)	21.9	481.5	23.1	508.5	228.5	-.338	.736**
Range (3 Months)	28.3	622.5	15.4	323.5	92.5	-3.391	.001*
Range (6 Months)	27.9	613.5	15.8	332.5	101.5	-3.174	.002*
MEPS (3 Months)	28.5	627.0	15.2	319.0	88.0	-3.496	.000*
MEPS (6 Months)	27.1	596.0	16.7	350.0	119.0	-2.743	.006*

*The difference is significant since p -value $<.05$, ** The difference is insignificant since p -value $>.05$

Regarding the post-operative complications among enrolled patients, 8 patients (36.4%) suffered from complications in group 1 compared to 13 patients (59.1%) in group 2. Accordingly, the secondary procedures done after main operation were also assessed as they were done in 6 (27.3%) patients in group 1 in comparison to 5 (22.7%) patients in group 2.

Comparing type of management and the outcome measures (complications & secondary procedures) items using Chi Square Test, there was insignificant difference between Double Plating and Y plate management techniques and outcome measures with p -value >0.05 (Table 4).

Table 4: The relation between type of management and the outcome measures (complications & secondary procedures).

Outcome Comparison Items	Group 1				Group 2				X ²	d f	p
	Yes		No		Yes		No				
	N	%	N	%	N	%	N	%			
Complications	8	36.4%	14	63.6%	13	59.1%	9	40.9%	2.277	1	0.131*
Secondary Procedures	6	27.3%	16	72.7%	5	22.7%	17	77.3%	0.121	1	0.728*

*The difference is insignificant since p -value $>.05$

Discussion

There are many controversies concerning the appropriate treatment of Intercondylar humerus fractures. Double plate fixation has been proved to produce reasonable clinical fallouts (Kelany et al., 2020). However, controversies still exist regarding the best site of plate placement during dual plate fixation. Sabalic et al. (2013) performed a study concerning the stability gained by parallel, perpendicular and Y plating in distal humerus fractures in which the authors proved that the displacements occurring with stress were minimal and within the range that permit union in the three types of plating. In intercondylar humeral fractures, The AO recommends using two locking-screw plates (a medial ulnar plate and a dorsal radial plate) for these fractures.

In accordance with Kumar et al. (2015) who reported insignificant statistical differences between the outcomes of parallel plating and perpendicular (Orthogonal) plating. On the contrary, other authors as Saragaglia et al. (2013) recommended Y plate which gave excellent medium-term results in fixation stability of the fracture and functional recovery of the elbow, even in elderly osteoporotic patients.

In this study, the mean range of motion among patients of group 1 was 84 ± 31 grades at 3 months and 98 ± 35 grades at 6 months while it was 48 ± 25 grades at 3 months and 71 ± 21 grades at 6 months among patients of group 2. Tian et al. (2013) found that mean range of motion 105 ± 26 in his study with patients by intercondylar humeral fractures managed by double plates while Subramanian et al. (2014) found that mean range of motion in patients with supra condylar –inter condylar fracture distal humerus managed by Y plate showed variability among C1 fracture, 75% had an arc of movement >100 grades while among C2 fracture, the authors reported that all patients had an excellent arc of motion except one with 80 grade and among C3 fracture all patients had an arc of motion >100 but 2 patients had restricted movement is supination about 20 grade.

In this study, the mean union time among group 1 was 3 ± 2 months with mean follow up period of 7 ± 1 month while among group 2, union time was 3 ± 1 month with mean follow up period of 7 ± 2 month but one patient from this group show metal failure 2 weeks after operation who is revised by double plating technique. Regarding complications, 36.4% of group 1 reported complication as stiffness, nonunion, infection, ulnar nerve injury and tourniquet palsy and 27.3% of this group underwent secondary procedures while 59.1% of group 2 reported complication as stiffness, infection, and metal failure and 22.7% of this group underwent secondary procedures.

Tian et al. (2013) reported that most patients at their study (double plate technique) achieved full union at 6 months postoperatively and only one patient had delayed bony union until 8 months. All patients were followed up for 12 to 38 months with an average of 19.2 ± 7.1 months. Postoperative complication was reported in up to 48% of patients, one patient suffered from transient ulnar nerve palsy however, no incidence of permanent nerve dysfunction.

Subramanian et al. (2014) reported that the average duration of follow up was 28.8 months (range 24-36 months) in supracondylar intercondylar fractures of the humerus treated by Y plate. The mean period for solid radiological fracture union was 16 weeks. In their study, one patient among C1 fracture suffered from postoperative infection resolved by antibiotic while among C2 fractures, many complications had been reported; one patient had post traumatic ulnar nerve palsy which has not completely recovered at up to 2 years, two fractures united with a varus deformity of 100 grades, one patient had ipsilateral mal-united supracondylar fracture, two patients had gustilo 1 open fractures with uneventful healing of wound and full union, one patient required implant removal at 8 months due to painful arc of motion and one case was found to have mild valgus instability.

The overall results of the present study are measured by Mayo Elbow Performance score at 3 months and 6 months. MEPS grading was 22.7% poor, 13.6% fair, 54.5% good and 9.1% excellent among group 1 while it was 76.2% poor, 19.0% fair, 4.8% good and 0.0% excellent among group 1 at 3 months. While at 6 months, MEPS grading was 13.6% poor, 4.5% fair, 36.4% good and 45.5% excellent in group 1 while it was 14.3% poor, 33.3% fair, 42.9% good and 9.5% excellent in group 2.

The results of Tian et al. (2013) found that 25 patients have been evaluated after double plating technique at 12m follow up and showed that 84.6% had excellent or good score. On the other hand, Subramanian et al. (2014) found that 18 patients managed by Y plate have been evaluated at 28.8 months follow up and showed that 50% had excellent result and 50% had good result in C1 compared to good result in the majority of C2 and C3 fractures.

Kumar et al. (2015) in a study done on 23 patient (age of patients ranged from 18 to 60 y) with inter condylar humeral fracture treated with surgical management with parallel plating, the authors assessed functional outcome with MEPS and the final follow up Mayo score was 96.32 ± 04.96 . All cases united within 6 months, and it was noted that maximum benefit can be achieved with aggressive

physiotherapy in first three months of surgery which can be achieved if anatomical rigid fixation is done. The authors also reported complication in some patients including 1 deep infection and 3 superficial suture line infections which resolved with a short course of antibiotics.

Modi et al.(2014) reviewed a series of 24 adults (age > 18 years) who underwent double plating for the distal humeral fractures and concluded that double plating techniques (orthogonal and parallel plating) have excellent outcomes after open reduction and internal fixation even in the presence of osteoporosis. Saragaglia et al. (2014) reviewed 74 patients with distal intercondylar humeral fractures with mean age 46± 23 managed by Y Plate in which mean MEPS was 97± 7 points (range, 40-100). There were 67 excellent results (MEPS: 90-100), five good (75-89), two fair and one poor. Radiologically, 73 fractures consolidated without complications while other patients experienced complications including 2 patients with non-unions, 2 patients with heterotopic calcification without functional impact and 3 patients with early posttraumatic osteoarthritis.

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