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ORIGINAL ARTICLE

Comparison of outcome of lambda plate versus double plate fixation in AO Type C fractures of distal humerus in adults.

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ABSTRACT… Objective: To compare the outcome of lambda plate versus double plate fixation in AO Type C fractures of the distal humerus in adults regarding bone union, range of motion and MEP score. **Study Design:** Randomized Clinical Trial. **Setting:** Sheikh Zayed Hospital, Lahore. **Period:** 1-01-2020 to 31-12-2020. **Methods:** After fitting in the inclusion criteria, 50 patients were signed up, 25 in each group. In group A, patients underwent surgery by using a lambda plate. In group B, patients underwent surgery by using a double plate. All this procedure was done by a researcher under the supervision of a supervisor. On follow up on each visit, patients were re-evaluated for MEP score. If MEP scores>75, then excellent to the good outcome was noted. Meanwhile, range of motion and bone union on x-rays was also evaluated. **Results:** In this study, the average age of the patients was 37.46±11.34 years; 32(64%). patients were male, while 18(36%). patients were females. After the 6th month, the excellent to good MEP score was noted in 23 patients (92%) of the double plate group versus the excellent to good MEP was found in 24 patients (96%) of lambda plate group, p-value=>0.999. After the sixth month, in the double plate group, the delayed union was noted in two patients (8%) of double plate group while in one patient (4%) of lambda plate group, p-value=0.261. **Conclusion:** This study concluded that in the management of fractures of distal humerus in adults, both lambda plate and double plate fixation are equally effective.

Key words: Double Plate, Humerus Fracture, Lambda Plate.

INTRODUCTION

Distal humeral fractures are relatively infrequent orthopaedic injuries.[1] These fractures account for around 2% of all fractures and 33% of all humerus fractures in the adult population.[2] In the UK, distal humeral fractures are very rare (5.7 per 100,000 people) and make up only 2% of all humeral fractures.[3]

Managing humeral fractures are challenging, mainly because of their particular position, small distal fragment size, presence of comminution, and the problem of osteoporosis in older adults.[4] Furthermore, distal humerus fractures often occur in either younger men or elderly women in a bimodal distribution. They are most commonly caused by high-energy trauma in youngsters and low-energy accidents in the old population, usually associated with osteoporosis.

Intra-articular distal humeral fractures are one of the most complex and difficult fractures faced by orthopedic surgeons. The main goal of surgery is anatomical reduction and restoration of the articular geometery, eansure axial alignment, provide stable fixation and facilitate rapid rehabilitation. But, the bone stock of distal humerus is inadequate, and stability might be problematic to attain in fractures of low pattern, comminution and osteoporosis. Intra-articular distal humeral fractures are complex fractures, which can substantially restrict the functionality of the elbow if managed improperly. Surgical management is proposed in many intra-articular fractures of distal humerus to restore functionality of elbow and it range of motion as well.[5]

These types of fractures are relatively uncommon but complicated. With a proper preoperative management plan and implementation of

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the surgical method, better results can be attained in numerous cases. Patients with such fractures must be counseled as they may have a loss of motion due to this fracture, while older patients co-morbid with osteoporosis along with widespread comminution must undergo total elbow replacement as a substitute to open reduction & internal fixation.[6]

Different classification systems are proposed during past years, but the most popular systems have close consideration to the number of columns affected and articular association. The AO/OTA classification divides these into three categories: extra-articular fracture (type A), intra-articular single column fracture (type B) & intra-articular both-column fracture (type C). These subtypes are further divided according to the location & comminution of fracture. Articular capitellum & trochlea fractures are classified as type-B3.[7]

Treatment varies due to anatomic complexity & is very challenging. Conservative management may be appropriate for non-displaced fractures or, in few comminuted fractures, but mostly surgical management is done these days. Management of humeral fractures of the distal end is still challenging for orthopedic surgeons and progressions in treatment alternatives endure to be made to attain the best outcomes for these complicated fractures.[8] However, previously such fractures were treated conservatively, improvement in the design of implants and surgical procedures can now improve the results of surgical fixation.[9]

Double plating is suggested for bi-columnar humeral fractures, and these plates can be implanted either; orthogonal or parallel to each other. In the particular surgical procedure, steady internal bone fixation and early meticulous postoperative mobilization are serious factors for successful results.[10] The outcomes of double plate fixation are better than single plate fixation for distal humerus fractures.

In 1992, an ''arms-down'' Y design plate was developed, known as Lambda® plate (Zimmer, Étupes, France). In 1997, biomechanical properties of the Lambda plate were established by Fornasiéri et al. This plate has been thoroughly in use since 1992 for the treatment of humerus fracture of the distal end. Surgical repair of intra-articular distal humeral by open reduction and internal fixation with Lambda plate is one of the most effective methods, which ensures stable osteosynthesis and prevents loss of reduction as contribution to better functional results.[11]

One trial found that according to MEP score, excellent to good MEP score was achieved in 83.3% with lambda plate and 84.6% with double plate ($p>0.05$) and range of motion was also almost equal, i.e., 106.2 ± 22.0^{o} with double plate and 105.0 ± 21.7^{o} with lambda plate ($p>0.05$). Complications occurred in 30.8% cases with a double plate while remaining 69.2% showed complete bone union. On the other hand, 25% cases in lambda plate fixation had complications, while 75% had complete bone union without any complication.[12]

Saragaglia et al., found that excellent to good MEPS score was achieved in 96% cases with lambda plate for humerus fracture and mean active elbow flexion was 133 ± 13^{o} and complete bone union was achieved in 97.5% cases. In comparison, 2.5% had nonunion due to complications.[1]

The rationale of this study was to compare the outcomes of lambda plate versus double plate fixation in patients with AO Type C distal humerus fractures. The literature shows that lambda plate and double plate both are equally effective. However, little work has been done in this regard due to a lack of local evidence. As a result, we could not deploy a more effective method to manage distal humeral fractures. Therefore, we wanted to carry out this study to obtain local evidence. This will help us enhance our practice and obtain local magnitude, which we will use to implement a more effective method for managing intra-articular distal humeral fracture. This will also decrease the burden for surgeons and patients by improving patients' outcomes and decreasing complications and treatment costs.

METHODS

In the Orthopaedic Department of Sheikh Zayed Hospital in Lahore, a randomized clinical trial took place from 1-01-2020 to 31-12-2020. The study comprised a total of 50 patients selected through non-probability consecutive sampling fulfilling the inclusion criteria and randomization was done via lottery method. To figure out the sample size, 80% of the test's power, a 95% confidence level, and the expected rate of bony union taken 97.5% with the lambda plate and 69.2% with the double plate respectively. The institutional review board gave the study the green light via reference no UHS/TS/3825. The study encompassed patients aged 16-65 years, either gender and presenting with AO Type C distal humeral fracture while those with neurovascular injury, pathological fractures, having previous surgery and with grade II or III open fractures were refused from inclusion in study. All patients gave their written permission after being fully informed.

For surgery, general anesthesia was given to the patient. The patient was placed in a lateral decubitus position with operated arm upwards with axillary support. A radiolucent arm roll on the side of the operating table supports the operated arm. A conventional posterior midline incision was used, preventing the tip of the olecranon. Exploration and mobilization of ulnar nerve was done. The fracture site was approached via Triceps fascial tongue exposure. The triceps flap was created distally and is about 10 cm in length and 2-3 cm in width. Articular fragments were held in place with pointed reduction clamp after reduction and ultimately with a K-wire. A positional screw was applied to hold the fragments. In very low-lying fractures K-wire was retained in place. Reduction of supracondylar fracture fragments was done with a reduction clamp and was held in place temporarily with K wires. The definite fixation was done using either double plating or lambda plate. Lambda plate was applied on posterior surface with its limbs molded on medial and lateral column of humerus. Double plate fixation was done in orthogonal orientation. 3.5mm reconstructive plate was applied on posterior surface and 1/3 tubular plate on medial surface. Triceps was repaired with an absorbable suture. The ulnar nerve was left in situ or transposed to avoid implant irritation. Drain placed, and the wound was closed in a reverse manner. A sterile dressing was subsequently placed followed by a posterior mold splint with the elbow in 60 -70 degrees of flexion. All this procedure was performed under the supervision of a supervisor. After surgery, patients were shifted to the postoperative ward.

Figure-1. Pre op X-ray of a 40y/M with AO type C Distal Humerus fracture FIG2: Post op X-ray after Lambda plate fixation

All data was entered in and analyzed by using SPSS version 21. The quantitative variables like age, duration of fracture, MEP score and range of motion was calculated as mean ± standard deviation. The qualitative variable like gender,

anatomical side, cause of fracture, bone union and excellent to the good outcome was presented as frequency and percentage. Both groups were compared for excellent to a good outcome and bone union by using the chi-square test and mean range of motion using independent samples t-test. P-value<0.05 was considered significant. Data was stratified for age, gender, and anatomical side, duration of fracture and cause of fracture. Post-stratification, respective tests of significance were applied to compare outcomes in both groups for each stratum. P-value<0.05 was considered significant.

RESULTS

In the double plate group, the mean age of the patients was 36.12±11.19 years versus 38.80±11.56 years in the lambda plate group, p-value=0.409. In the double plate group, 8(32%) patients were female and 17(68%) patients were male, while in the lambda plate group, 10(40%) patients were females and 15(60%) patients were male, p-value=0.556. In the double-plate group, the average duration of fracture of the patients was 5.80±3.56 days versus, while 5±2.59 days in the lambda plate group, p-value=0.369. In the double plate group left anatomical side was involved in 15(60%) patients versus 16(64%) patients seen with left side in lambda plate group. Similarly, in the double plate group right anatomical side was involved in 10(40%) patients in comparison to 9(36%) patients in lambda plate group, p-value=0.771.The average MEP scores of the patients in double plating group were 77.40±10.62, 83.00±10.61 and 87.40±10.42 at 1st, 2nd and 6th month respectively while in the lambda plate group, the average MEP scores of the patients were 78.60±10.16 (p-value=0.685), 84.60±10.29 (p-value=0.591) and 89.40±11.023 (p-value=0.513) at similar months. In our study after the first month, in the double plate group, the excellent to good, fair and poor MEP score was noted in 19(76%), 4(16%) & 2(8%) patients, respectively and in lambda plate group the excellent to good, fair and poor MEP score was found in 20(80%), 4(16%)& 1(4%) patients respectively, i.e. (p-value=0.621).

After the second month, in double plate group the excellent to good, fair and poor MEP score was noted in 22(88%), 2(8%)& 1(4%) patients respectively and in lambda plate group the excellent to good, fair and poor score MEP was found in 22(88%), 2(8%)& 1(4%) patients respectively, i.e.(p-value=>0.999). After the 6th month, in the double plate group, the excellent to good, fair and poor MEP score was noted in 23(92%), 2(8%)& 0(0%) patients, respectively and in the lambda plate group the excellent to good, fair and poor MEP score was found in 24(96%), 0(0%), 1(4%) patients respectively (p-value=>0.999). After the 6th month follows up, in the double plate group, the complete union was noted in 23(92%) patients, and in the lambda plate group, the complete union found in 24(96%) patients, p-value>0.999.

In this study, after the first month, in the double plate group, the infection was found in 2(8%) patients, whereas in the lambda plate group, there was not any patient who had the infection (p-value=>0.999). After the second month, the implant failure requiring re-fixation was seen in 1(4%) patient both in double plate and the lambda plate group, (p-value=0.406). After the 6th month, in the double plate group, the delayed union was noted in two (8%) patients and in the lambda plate group; it was seen in one patient (4%), p-value=>0.999.

		Study Groups		Total	P-Value
		Double Plate	Lambda Plate		
Gender	Female	8	10	18	0.556
		32.0%	40.0%	36.0%	
	Male	17	15	32	
		68.0%	60.0%	64.0%	
Total		25	25	50	
		100.0%	100.0%	100.0%	

Table-I. Comparison of gender between study groups

MEP		Study Groups		Total	P-Value
		Double Plate	Lambda Plate		
1st Month	Excellent to good	19(76.0%)	20 (80.0%)	39 (78.0%)	0.621
	Fair	4 (16.0%)	4 (16.0%)	8 (16.0%)	
	Poor	2 (8.0%)	1(4.0%)	3 (6.0%)	
2nd Month	Excellent to good	22 (88.0%)	22 (88.0%)	44(88.0%)	>0.999
	Fair	2 (8.0%)	2(8.0%)	4 (8.0%)	
	Poor	1(4.0%)	1 (4.0%)	2 (4.0%)	
6th Month	Excellent to good	23 (92.0%)	24 (96.0%)	47 (94.0%)	>0.999
	Fair	2 (8.0%)	0 (0.0%)	2 (4.0%)	
	Poor	0(0.0%)	1 (4.0%)	1 (2.0%)	

Table-II. Comparison of MEP at 1st, second & sixth month follow up between study groups

Bone Union		Study Groups		Total	P-Value
		Double	Lambda		
6th Month	Complete	23(92%)	24 (96.0%)	47 (94.0%)	>0.999
	Delayed union	2 (8.0%)	1(4.0%)	3 (6.0%)	

Table-II. Comparison of the Bone union at sixth month between study groups

DISCUSSION

Fractures of the distal humerus form an important entity of orthopedic practice but are relatively rare. Due to the anatomical complexity and variation in fractures, an individualized approach is needed for their management. A few benefit from a conservative approach, but many require surgery for anatomical reduction and stabilization of fracture. This is to ensure proper joint assembly and early return to work that is the only way to avoid elbow stiffness and an acceptable level of joint mobility to sustain normal life requirements.[13]

Distal humerus fixation restores the integrity of the medial, lateral condyles and brings back the congruity of the capitulum-trochlea joint as well. Although the best way to treat distal humerus fractures is still debatable, double plate fixation provides adequate results, even in patients with complicated fractures with intra-articular extension.[14]

Fifty patients signed up for current study. The average age of the patients was 37.46±11.34 years with ages ranging from 16 to 62 years and 32(64%) patients were male while 18(36%) patients were females. Greater number of male patients in the study is because of more road traffic accidents in this group. The mean duration of fracture was 5.40±3.11 days with minimum and maximum of 1 & 13 days, respectively. This looked a lot like the results that Tian et al interpreted, in which mean age of patients was 37 years (range 18 to 56) and there were 60 percent male patients and 40 percent female patients, with average duration of 7 days (range 0 to 14 days) between trauma and surgery. Observation regarding anatomical side involvement was also similar to current study.

In this study, both types of platting are equally effective in the management of distal fracture of humerus in adults. In this study, after the sixth month, the excellent to good MEP score was noted in 23(92%) patients of double plate group while score was found in 24(96%) patients of lambda plate group, (p-value=>0.999). Flexion arc was also comparable. These outcomes in both groups were obtained by initiation of early physiotherapy after soft tissue healing. Our findings were similar to the study done by Tian et al. which reported insignificant differences in clinical outcomes between the two said plating techniques. In that particular study, the participants were followed for a total of 12-38 months in group I and almost the same for group II. All patients had healed osteotomies and fractures by the end of the study. Only 4 patients in group I and 3 patients in group II had complications, and 84.6% of those in group I and 83.3% of those in group II had excellent to good Mayo Elbow Performance Scores.[12] In the current study, after the six months follow up, in the double plate group, the complete bone union was noted in 23 (92%) patients and in the lambda

plate group, the complete union was found in 24 (96%) patients. These results were comparable to above cited studies. This meant that both methods provide adequate fixation for bone union. In both groups, we used the triceps tongue approach in contrast to olecranon osteotomy technique used in most studies. It had advantage that ulna was not fractured, fewer implants were utilized, and the duration of surgery was shortened by avoiding an olecranon osteotomy. However, in the lambda plate group, plate was applied on the posterior surface which was associated with lesser soft tissue dissection, periosteal stripping and shorter duration of surgery. Similarly, after the sixth month, in the double plate group, the delayed union was noted in two (8%) patients, and in the lambda plate group, it was found in one (4%) patient (p-value=>0.999). There was statistically insignificant difference between the two groups in terms of complications.

Saragaglia et al. found that excellent to good MEPS score was achieved in 96% cases with lambda plate for humerus fracture and mean active elbow flexion was 133±13° and complete bone union was achieved in 97.5% cases while 2.5% had non-union due to complications.[1]

A study by Matthias Luegmair et al. stated that after open reduction & internal fixation with Lambda plating surgically to repair intra-articular distal humerus fractures effectively produces stable osteosythesis without the danger of losing reduction or fixation, subsequently producing an excellent functional outcome.[11]

Talking about inter-condylar fractures which were treated with Y plate, Mahapatra and Abraham et al. reported mean MEP score of 80±10.5 in which only 13.33% patients had excellent score while 67% patients scored good.[15]

However, Krishna Bahadur Bista et al. reported in their study that lambda plate gives excellent results with regards to pain, range of motion and function when treating distal humerus fractures. In 93.33% patients fixed with lambda plate, excellent to good outcomes were obtained at the last follow up. A dramatic increase in the range of motion was observed with each follow up (P<0.001). At the final follow-up, the average angle of flexion was 117.53±11.74°, whereas extension lag was 7.53±4.86°. Most patients bones were fully fused at 19.84±2.38 weeks.[16]

The shape of Lambda plate is well adapted to shape of distal humerus providing stability in fixation and allowing for early mobilization of the elbow, leading to good functional recovery. For intra-articular fracture fragments malleolar screw or malleolar-screw and k-wire is used for fixation. For fixation of Lambda plate at least two screws should be used for each arm.[17] One more study done by Matthias Luegmair et al. showed that the intra-articular distal humeral fractures when repaired surgically by open reduction & internal fixation with Lambda plate is an effective method in providing adequate osteosynthesis and ultimately a good functional outcome.[11]

Similarly, previous literature also showed good efficacy of the double plate technique. The most commonly accepted operative procedure for treating distal humerus fractures is open reduction with internal fixation using a dual plate technique. This is due to the fact that the double plate fixation provides stabilization to both columns and thus satisfactory clinical results.[18]

On the contrary, one study found that a double plate structure, regardless of plate type 3.5 mm reconstructive plate and/or 1/3 tubular plate), was much more rigid and fatigue resistant than a single “Y” plate or cross screws. If the surgeon prefers stable fixation of the supracondylar or bi-condylar distal humeral fractures, double plate construct at right angles (the ulnar plate on medial surface, the lateral plate on posterior surface) is the optimal approach.[19]

Athwal et al., described a study of 32 patients with type C distal humerus fractures managed with parallel plates, two of which had a minor wound problem, and two patients underwent radial forearm flap.[20] However, in our study, after the first month, in the double plate group, the infection was found in 2(8%) patients, which was treated by antibiotics and wound care. Whereas

in the lambda plate group, there was not any patient who had the infection (p-value=>0.999). This could be due to less soft tissue dissection, minimal periosteal stripping and short duration of surgery.

The limitation of our study was a relatively small number of participants and short duration of follow-up. In future, further researches should be done with a larger sample size to check the findings of our study.

CONCLUSION

This study concluded that in managing fractures of distal humerus in adults, both lambda plate and double plate fixation are equally effective.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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2	Syed Wasif Ali Shah	Proforced & Procedure supervision.	
3	Muhammad Abdul Shakoor	Manuscript writing.	
4	Shafqat Abbas Raza Khan	Data collection.	