

Functional outcome of the treatment of AO-ASIF type C distal humerus fracture using Lambda plate

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ABSTRACT

Introduction: Although the use of two plates for the treatment of type-C distal humerus fracture is popular, site of plate placement still is under debate. Use of Lambda plate for the fracture treatment can be easier and settle the dispute. This study aims to evaluate the functional outcome of the surgery using Lambda Plate. This can be a reference for surgeons and helps them make the decision about choice of implant for type C distal humerus fracture treatment among Nepalese people. **Methods:** This interventional study used Lambda plate for the treatment of type C fracture of distal humerus. Patients were examined at 4, 12, and 24 weeks respectively for the measurement of the outcome. Visual analogous scale was used for assessment of pain, range of motion for functional recovery and Mayo Elbow Performance Score was used for the assessment of functional outcome. Paired-samples t-test and linear regression was used to for data analysis. **Results:** Functional outcome at the last follow-up was excellent in 24(53.33%) patients, good in 18(40%) patients and fair in 3(6.67%) patients. Range of motion of elbow increased significantly with every follow-up (p-value <0.001). Average angle of flexion at last follow-up was $117.53^{\circ} \pm 11.74$ while loss of extension was $7.53^{\circ} \pm 4.86$. Average number of patients had their fracture union at 19.84 ± 2.38 weeks. There was no association of age, sex and union weeks with functional outcome when measured with MEPS. **Conclusion:** Fixation of distal humerus fracture by using Lambda plate gave excellent and satisfying outcome in terms of pain, range of motion and objective functional outcome.

Key Words: Lambda plate, Distal humerus, Fracture.

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INTRODUCTION

Fracture of distal humerus accounts for 3% of all the fractures in adult.¹ Although the fracture is rare, it is challenging to treat due to complex anatomy of elbow joint and the adjacent neurovascular arrangement.^{2,3} Improper management of type C fracture of distal humerus may lead to complications and disability. Immediate complications include limb threatening due to involvement of neurovascular structure while late complications include derailed functional status.⁴ For the management of type C distal humeral fracture, consensus has been made in favour of surgery which enable to achieve stable osteosynthesis. However, surgical technique to be applied is still a matter of debate.⁵⁻⁷

Although the methods for the stable internal fixation and reconstruction of the articular surface was introduced by Arbeitsgemeinschaft Für Osteosynthesefragen (AO)-Association for the Study of Internal Fixation (ASIF), techniques have changed a lot making the results predictable.⁸

In line, open reduction with internal fixation by dual plate technique has been the most widely accepted surgical technique for the distal humerus fracture treatment. This is because two plate technique provides bi-columnar stabilization and hence excellent clinical outcomes.⁹⁻¹² Plates are either placed perpendicularly (orthogonal plane) as per the early description of AO-ASIF, or placed parallelly (at 180 degree) as proposed later by O'Driscoll.¹³ Nevertheless, some surgeons also prefer Y plating in which two plates are placed as inverted 'Y' on the posterior surface of medial and lateral supracondylar ridges in coronal plane.¹⁴ Further development of instrumentation in line of Y plating has presented 'Lambda Plate' which are already in use for the treatment with excellent result.^{15,16}

Although few literatures are available which report functional outcome of the use of Lambda plate,^{14,16-18} evidence is not sufficient. Gap remains regarding assessment of functional outcome with the use of lambda plate particularly in Nepalese population. Therefore, this study aims to evaluate and report the functional outcome of the distal humeral fracture treatment using Lambda plate in Nepalese population. Result of this study would be an evidence and help surgeons to make decision about the implant selection in favor of Lambda plate in the management of type C distal humerus fracture.

MATERIALS AND METHODS

Study population: This prospective interventional study was carried out in Gandaki Medical College Teaching Hospital and Research Center, Pokhara, Nepal among 45 participants. In this study, the age of the patients ranged from 20-60 years were admitted within 7 days of fracture and classified as AO-ASIF type C fracture of distal humerus and those who gave written consent and underwent surgery between January 2016 to January 2020 were included. Patients having other comorbidities, head injury, previous history of elbow surgery and vascular injury needing repair were excluded from the study. Ethical approval for the study was obtained from Institutional Review Committee of Gandaki Medical College.

Lambda Plate: Lambda plate is a compression plate with oval holes without locking screws. It is a sectile, Y shaped, single piece flat cast which can be contoured. Its diaphyseal branch is 3.6 mm thick whereas epiphyseal arms are 2.5 mm thick angled at 50 degree apart.¹⁵ Lambda plates used in this study was obtained from Sharma Orthopedics (India).

Surgical Technique: Use of Lambda plate is uncommon in Nepal and hence we followed the surgical procedure according to the previous literatures.¹⁹⁻²⁰ Briefly, we followed

triceps sparing posterior approach to the distal humerus for midline posterior incision. Affected arm was placed at 90° of elbow flexion on a support with patient in lateral decubitus position on operating table. Use of tourniquet was avoided. A midline posterior incision was given and extended 5-8 cm distal to the olecranon tip. Radial nerve passing from posterior to anterior compartment was identified and triceps was retracted exposing posterolateral humeral. Medially, ulnar nerve was identified and released it from cubital tunnel and then posteromedial aspect of the distal humerus was exposed. For intercondylar fracture component 4 mm cannulated cancellous screw was used for fixation. Then, fracture was reduced and fixed with Lambda Plate and screws. Arm was immobilized at 90° of elbow flexion with posterior slab for 2 weeks.

Outcome assessment tools and technique: All the patients were examined at 4, 12 and 24 weeks for the evaluation of progressive outcome. We used Visual Analog Scale (VAS) for the assessment of pain which has scale ranging from 0 "no pain" to 10 "worst imaginable pain". It is a self-assessed pain measuring tool. Functional recovery was assessed by measuring range of motion (ROM) of elbow. We measured, both flexion and extension-lag, at 4, 12 and 24 weeks to document range of motion (ROM) of elbow. For objective functional assessment, Mayo Elbow Performance Score (MEPS) was recorded at 24 weeks. MEPS is a four-part scale consisting of 100 points. A 100 points scale is classified as poor (<60), fair (60-74), good (75-89), and excellent (90-100). We also measured fracture union week to assess its effect over the outcome of surgery. Decision of choosing these scales and scores for measuring functional outcome of internal fixation by Lambda plate was based on previous literature.^{16, 21-23}

Statistical Analysis: Descriptive statistics was assessed and presented in the form of either mean or median and as frequency. Inferential statistics 'Paired-samples t-test' was used to compare means of VAS and ROM. In order to see the association of MEPS with predicting variables such as age, sex and union of fracture, we used multivariable linear regression. All the data analysis was performed with statistical software STATA version 15.1.

RESULTS

The mean age of the participants in this study was 33.87±9.3. Fracture was reduced, fixed with Lambda Plate & screws and arm was immobilized at 90° of elbow flexion with posterior slab for 2 weeks (figure 1a-b). Statistics analysis shows that distal humerus fracture in adults were more common among females (60%) compared to males (40%). ROM showed

that angle of flexion kept on increasing from around 100⁰ to 109⁰ and then to 118⁰ at 4,12 and 24 weeks, respectively. Conversely, loss of angle of extension declined till 7.53⁰ at 6 months. Data also showed that the median number of weeks needed for the fractures to be united in this study was 20 weeks. In terms of MEPS score, 53.33% of the patients documented to have excellent (≥ 90) outcome and the good thing was that none of the patients had poor (<60) outcome (Table1).



Fig 1: a- Pre-surgical radiograph of distal humerus fracture; b- post-surgical radiograph of fracture fixed using Lambda Plate.

Table 1: Distribution of variables of patients with distal humerus fracture (n=45)

Variables	Mean (SD)	Median (IQR)
Age (years)	33.87 (9.3)	33(26-39)
Sex		
Female	27 (60%)	
Male	18 (40%)	
VAS at 4 weeks	3.09 (0.95)	3 (2 - 4)
VAs at 12 weeks	1.36 (0.74)	1 (1 - 2)
VAs at 24 weeks	0.33 (0.52)	0 (0 -1)
ROM flexion at 4 weeks	100.44 ⁰ (12.43 ⁰)	100 ⁰ (90 ⁰ - 113 ⁰)
ROM flexion at 12 weeks	108.89 ⁰ (12.18 ⁰)	111 ⁰ (101 ⁰ - 119 ⁰)
ROM flexion at 24 weeks	117.53 ⁰ (11.74 ⁰)	124 ⁰ (108 ⁰ - 129 ⁰)
ROM extension lag at 4 weeks	41.91 ⁰ (5.66 ⁰)	41 ⁰ (38 ⁰ - 46 ⁰)
ROM extension lag at 12 weeks	11.98 ⁰ (5.02 ⁰)	11 ⁰ (8 ⁰ - 16 ⁰)
ROM extension lag at 24 weeks	7.53 ⁰ (4.86 ⁰)	5 ⁰ (4 ⁰ - 11 ⁰)
Time of Union of fracture (weeks)	19.84 (2.38)	20 (18 - 22)
MEPS	86.24 (8.95)	90 (80 - 95)
MEPS categorized		
Excellent (≥ 90)	24 (53.33%)	
Good (75-89)	18 (40%)	
Fair (60-74)	3 (6.67%)	
Poor (<60)	None	

Results of paired samples t-test as shown in table 2 provided strong evidence (p-value<0.001) that pain decreased after 12 weeks compared to 4 weeks [95% CI= -1.97, -1.5] and decreased further at 12 weeks follow-up [p-value <0.001, 95% CI= -1.22, -0.82]. Comparison of ROM in terms of mean angle of flexion at different time of follow-up gave strong evidence that the ability to flex elbow increased by almost 8⁰ [4 week to 12 weeks: p-value<0.001, 95% CI = 6.66, 10.44]

in each follow-up [12 to 24 weeks; p-value<0.001, 95% CI = 6.88, 10.41]. Conversely, lag in extension of elbow decreased every time on follow-up, though by small degree (4.44⁰) on 3rd follow-up at 24 weeks. Nevertheless, decline in lag while extension was significant (p-value <0.001) [Table2].

Table 2: Paired-samples t-test to find difference in mean of surgery outcome at different time (n=45)

Assessment tool	score measuring time	Mean difference	P-Value	95% CI	
Visual Analog scale (VAS)	12weeks-4weeks	-1.73	<0.001	-1.97	-1.5
	24 week - 12weeks	-1.02	<0.001	-1.22	-0.82
ROM Flexion (degree)	12 week -4 weeks	8.44 ⁰	<0.001	6.66	10.44
	24 week - 12 weeks	8.64 ⁰	<0.001	6.88	10.41
ROM extension lag (degree)	12 week -4 weeks	-29.93 ⁰	<0.001	-30.75	-29.11
	24 week - 12 weeks	-4.44 ⁰	<0.001	-4.97	-3.92

We also tried to find out the association of age and sex of patients with the objective functional outcome (MEPS) using multivariate linear regression. Result showed that there may or may not be the association of age because 95% confidence interval included null value (95% CI; -0.215, 0.402). P-value provides weak evidence of association with age (p-value=0.543). The evidence of association of MEPS with sex (p-value=0.714) or fracture union week (p-value=0.382) were also weak [Table3].

Table 3: Multivariable Linear Regression analysis to find the association of Mayo Elbow Performance Score (MEPS) with predicting variables (n=45)

	MEPS	Coef.	P-value	95% CI	
Age		0.094	0.543	-0.215	0.402
Fracture union weeks		-0.513	0.382	-1.686	0.659
Sex	Female	base			
	male	1.057	0.714	-4.731	6.845

DISCUSSION

Stability of the medial and lateral columns are as important as congruity of elbow joint while fixing distal humerus fracture to regain excellent functional recovery. Two plate fixation techniques have been documented to have satisfactory outcome, but disputes still exist regarding site of fixing plate. This is because clinicians use one of the three models viz; parallel plating, perpendicular plating and Y plating, while all three models have shown that the stress related displacements were minimal.²⁴ Although not many and not in Nepalese people, literature suggested that Lambda plate fitted well with the shape of distal humerus

and provided good functional recovery along with early mobilisation.¹⁴ Thus, this study was conducted to report the outcome of the use of Lambda plate for the fixation of type C humeral fracture among Nepalese people. This would help surgeons to make decision while selecting surgical protocol and would help bring uniformity in surgery technique. Strength of the study was that it used inferential statistics 't-test' and 'linear regression' draw the robust conclusion and adjust confounders while most of other studies used only descriptive statistics.^{17,18}

The average age of the participants in this study was 33.87±9.3 years which was almost similar to the study of Mahapatra et al.²⁵ Percent of females (60%) in our study was higher than that of males (40%) which contradicted many other previous studies.^{26,27} The probable cause may be the mode of injury as females in hilly regions like Pokhara and its periphery most often visit difficult hills for farming and animal husbandry while males are involve in official job and go abroad. On contrary, injured males in the previous studies were greater in percentage may be because of driving. Thus, further study is needed to verify the mode of injury. We found that pain decreased with time and almost vanished at 24 weeks with mean VAS 0.33±0.52 when range of motion was 117.53°±11.74°/7.53°±4.86°. This result was expected but it differed from Nouraei et al.²⁸ who found that mean VAS 3.3 when flexion was over 100 degree. The probable reasons that patients experienced higher pain in his study might have been the low tolerance capability of patients compared to Nepalese, moreover, VAS is a subjective measurement.

Although the normal angle of flexion is 140° to 150°, researches have shown that minimum of 85% flexion is necessary to perform all the basic life activities.^{29,30} Depending upon these previous studies, functional recovery in terms of range of motion was appreciable in our study (117.53°) which was comparable to the previous studies reporting recovery of 120° or 130° or up to 112°. Furthermore, loss of extension was only 7.53° in our study but extension loss was greater in other studies.^{14,17,18}

Saragaglia et al.¹⁶ reported that 89.5% of patients had excellent MEPS with mean MEP score of 97±7 for distal humerus fracture treatment with Lambda plate. In response to intercondylar fracture treatment with dual Y-plate, a study reported to have mean MEP score 80±10.5 and only 13.33% patients performed excellent whereas 66.67% scored good.²⁵ Participants of the study conducted by Mann et al. for the treatment of supracondylar and intercondylar fracture of distal humerus with pre-contoured plate reported that only 9% had excellent MEP score while 53% had good score.¹⁷ On the contrary, our study showed that 53.33% of patients

scored excellent, 40% scored good, 3% scored fair and none scored poor with mean MEP score of 86.24±8.95 and median MEP score 90 (80-95). Strength of this study was that we used inferential statistics for the data analysis which gave robust and reliable result while many other related studies used only descriptive statistics. However, limitation of our studied cannot be overlooked has it used small sample size and further study is needed with large sample size. Only one patient in this study got infected who was treated with antibiotics and average number of weeks required for the union of fracture was 20 weeks.

CONCLUSION

This study found that patients achieved excellent outcome and functional recovery when treated for AO-ASIF type C fracture of distal humerus with Lambda plate. Therefore, based upon evidence of this study regarding functional outcome, we report that Lambda plate can be used for the treatment of type C fracture of distal humerus.

Conflict of Interest: None

REFERENCES

1. Robinson CM, Hill RM, Jacobs N, Dall G. Adult distal humeral metaphyseal fractures: epidemiology and results of treatment. *Journal of orthopaedic trauma*. 2003;17(1):38-47. DOI: 10.1097/00005131-200301000-00006
2. Cannada L, Loeffler B, Zadnik M, Eglseder A. Treatment of high-energy supracondylar/intercondylar fractures of the distal humerus. *Journal of surgical orthopaedic advances*. 2011;20(4):230-5.
3. 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. DOI: 10.1016/j.injury.2011.06.418
4. Mahan ST, May CD, Kocher MS. Operative management of displaced flexion supracondylar humerus fractures in children. *Journal of Pediatric Orthopaedics*. 2007;27(5):551-6. DOI: 10.1097/01.bpb.0000279032.04892.6c
5. Elhage R, Maynou C, Jugnet P, Mestdagh H. Résultats à long terme du traitement chirurgical des fractures bicondyliennes de l'extrémité distale de l'humérus chez l'adulte. *Chirurgie de la main*. 2001;20(2):144-54. DOI: 10.1016/S1297-3203(01)00026-9
6. Korner J, Lill H, Müller 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;34:20-30. DOI: 10.1016/j.injury.2003.09.022
7. Kundel K, Braun W, Wieberneit J, Rüter A. Intraarticular distal humerus fractures: factors affecting functional outcome. *Clinical Orthopaedics and Related Research*. 1996;332:200-8. DOI: 10.1097/00003086-199611000-00027
8. Müller ME, Perren S, Allgöwer M, Müller ME, Schneider R, Willenegger H. *Manual of internal fixation: techniques recommended by the AO-ASIF group*: Springer Science & Business Media; 1991. DOI: 10.1007/978-3-662-02695-3
9. Eralp L, Kocaoglu M, Sar C, Atalar A. Surgical treatment of distal intraarticular humeral fractures in adults. *International orthopaedics*. 2001;25(1):46-50. DOI: 10.1007/s002640000198
10. Korner J, Lill H, Müller LP, Hessmann M, Kopf K, Goldhahn J, et al. Distal humerus fractures in elderly patients: results after open reduction and internal fixation. *Osteoporosis international*. 2005;16(2):S73-S9. DOI: 10.1007/s00198-004-1764-5
11. Mckee MD, Wilson TL, Winston L, Schemitsch EH, Richards RR. Functional outcome following surgical treatment of intra-articular distal humeral fractures through a posterior approach. *JBJS*. 2000;82(12):1701. DOI: 10.2106/00004623-200012000-00003
12. Pajarinen J, Björkenheim J-M. Operative treatment of type C intercondylar fractures of the distal humerus: results after a mean follow-up of 2 years in a series of 18 patients. *Journal of shoulder and elbow surgery*. 2002;11(1):48-52. DOI: 10.1067/mse.2002.119390
13. Nauth A, McKee MD, Ristevski B, Hall J, Schemitsch EH. Distal humeral fractures in adults. *JBJS*. 2011;93(7):686-700. DOI: 10.2106/JBJS.J.00845
14. Luegmair M, Timofiev E, Chirpaz-Cerbat J-M. Surgical treatment of AO type C distal humeral fractures: internal fixation with a Y-shaped reconstruction (Lambda) plate. *Journal of shoulder and elbow surgery*. 2008;17(1):113-20. DOI: 10.1016/j.jse.2007.04.007
15. Formasier C, Staub C, Tourne Y. Biomechanical comparative study of three types of osteosynthesis in the treatment of supra and intercondylar fractures of the humerus in adult. *Rev Chir Orthop Reparatrice Appar*. 1997;83(3):237.
16. Saragaglia D, Rouchy R-C, Mercier N. Fractures of the distal humerus operated on using the Lambda® plate: report of 75 cases at 9.5 years follow-up. *Orthopaedics & Traumatology: Surgery & Research*. 2013;99(6):707-12. DOI: 10.1016/j.otsr.2013.04.007
17. Mann H. Functional Outcome of Supracondylar and Intercondylar Fractures of Distal Humerus Fixed With Precontoured Plates in Adults. *Medical Science*. 2016;5(10).
18. Singh SP. *Fractures of Distal Humerus Operated with Using Lambda Plate*. 2018.
19. Hoppenfeld S, DeBoer P, Buckley R. *Surgical exposures in orthopaedics: the anatomic approach*: Lippincott Williams & Wilkins; 2012.
20. Schildhauer TA, Nork SE, Mills WJ, Henley MB. Extensor mechanism-sparing paratricipital posterior approach to the distal humerus. *Journal of orthopaedic trauma*. 2003;17(5):374-8. DOI: 10.1097/00005131-200305000-00009
21. Longo UG, Franceschi F, Loppini M, Maffulli N, Denaro V. Rating systems for evaluation of the elbow. *British Medical Bulletin*. 2008;87(1):131-61. DOI: 10.1093/bmb/ldn023
22. Norkin CC, White DJ. *Measurement of joint motion: a guide to goniometry*: FA Davis; 2016.
23. Turchin DC, Beaton DE, Richards RR. Validity of observer-based aggregate scoring systems as descriptors of elbow pain, function, and disability. *JBJS*. 1998;80(2):154-62. DOI: 10.2106/00004623-199802000-00002
24. 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:S56-S61. DOI: 10.1016/S0020-1383(13)70200-6
25. Mahapatra S, Abraham VT. Functional Results of Intercondylar Fractures of the Humerus Fixed with Dual Y-Plate; A Technical Note. *Bulletin of Emergency & Trauma*. 2017;5(1):36.
26. Liu D, Li P. Treatment of distal humerus fracture with double-plating fixation. *Zhongguoxiufuchongjianwaikexazhi= Zhongguoxiufuchongjianwaikexazhi= Chinese journal of reparative and reconstructive surgery*. 2010;24(6):680-2.

27. Özer H, Açar Hİ, Cömert A, Tekdemir İ, Elhan A, Turanlı S. Course of the innervation supply of medial head of triceps muscle and anconeus muscle at the posterior aspect of humerus (anatomical study). Archives of orthopaedic and trauma surgery. 2006;126(8):549-53. DOI: 10.1007/s00402-006-0183-9
28. Nouraei M, Motififar M, Barazandeh M. Evaluation of Outcomes of Open Reduction and Internal Fixation Surgery in Patients with Type C Distal Humeral Fractures. Adv Biomed Res. 2018;7:3. DOI: 10.4103/abr.abr_283_15
29. Chonnaparamutt W, Supsi W. SEFRE: Semiexoskeleton Rehabilitation System. Applied Bionics and Biomechanics. 2016;2016:1-12. DOI: 10.1155/2016/8306765
30. Morrey B, Askew L, Chao E. A biomechanical study of normal functional elbow motion. JBJS. 1981;63(6):872-7. DOI: 10.2106/00004623-198163060-00002