

Original Research Article

Potential outcome of locking compression plate in proximal humerus fractures

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ABSTRACT

Background: Fractures of proximal humerus bone needs immediate attention as the delayed treatment might result in non-union, malunion, and avascular necrosis which are responsible for the pain and dysfunction. The aim of the present study is to evaluate the functional outcome of displaced proximal humerus bone fractures that are surgically managed by locking compression plate and to assess the potential complication.

Methods: The present study is the combination of both prospective and retrospective in which 30 patients with either Neer's three part or Neer's four-part proximal humerus fractures which were fixed with locking plate by a single surgeon. Functional outcome was measured by Constant Murley scoring (CMS) system.

Results: The final follow-up of the study showed that 21 patients (70%) had the result that ranged from good to excellent score whereas, 6 patients (20%) had moderate score and 3 patients had poor score in functional outcome according to CMS system. During follow-up, 3 complications (10%) were encountered.

Conclusions: The study concluded that proximal humerus locked compression plate is a valuable surgical method for the fixation of comminuted fractures of the proximal humerus as it is associated with excellent functional outcome. It also provides a stable fixation to permit early mobilization. Regaining medial cortical contact and establishing anatomical reductions decreases the complications that are associated with plate fixation.

Keywords: Comminuted fracture, Locking compression plate, Proximal humerus fracture

INTRODUCTION

Management of proximal humerus bones fractures is cumbersome as they are linked with higher morbidity. Proximal humerus bones fractures is the third most common type of fragility fracture with increasing incidence globally.¹ They are responsible for 6% of all the adult fractures.^{2,3} It is difficult to treat proximal humerus bones fractures when it is unstable, displaced, and comminuted. Conservative management for proximal humerus fractures are not beneficial as it might lead to incomplete union or malunion, and avascular necrosis (AVN) which causes disability in patients.⁴ Locking plates is the preferred type of intervention owing to its

biomechanical properties for the displaced proximal humerus fractures.^{5,6} It can be applied even in the fixation of osteoporotic bone.⁷ Moreover, newer advancement had been made in the fixation techniques to increase the chance of anatomic restoration but with the limitation of patients immobilization time which is responsible for stiffness.⁸⁻¹¹

Controversies exit regarding the method of choice for displaced proximal humerus fractures.¹² A recent review articles had discussed the potential complication apart from a literature survey from locking plate publications.^{13,14} But with the application of Neer's 4-parts classification system for fracture and comparison of

long term outcome of similar injuries had been made possible.¹⁵⁻¹⁷ Hence, the objective the current study is to evaluate the functional outcome of displaced proximal humerus fractures that are surgically managed by locking compression plate and to assess the potential possible complication.

METHODS

A combination of both prospective and retrospective study was conducted at Sri Ramachandra Medical College, Chennai from August 2015 to July 2017, comprising of 30 patients with proximal humerus fractures that were fixed with locking plate by a single surgeon. Informed consent was obtained from the patients. Patient's clinical information was collected in a proforma after careful clinical and radiological examination.

Inclusion criteria

Patients who are above the age of 18 years with displaced type III and type IV proximal humeral fractures were included in the study. Fracture that either met the indication for surgery as per Neer's classification like, angulation of the articular surface of more than 45 degrees or displacement of more than 1 cm between the major fracture segments.

Exclusion criteria

Patients who had open fractures, pathological fractures, pseudoarthrosis and previous surgery of the proximal part of humerus were excluded.

Evaluation of patients

Initially, all the patients were evaluated for associated injuries and stabilised in emergency room temporarily using cuff and collar. Subsequently, the patients were shifted for radiological examination of both X-ray (antero-posterior view) and CT scan (3D reconstruction). The standard Neer's classification was used to assess the type of fracture.¹⁸ Following anaesthesia fitness, the patient was taken for surgery immediately after obtaining the informed consent. The surgical procedures were completely explained to the patients and their relatives with possible expected complications before surgery.

Operative techniques

All the patients underwent surgery either under general or regional anesthesia. Patients were positioned in supine position with a sand bag under the scapula of the involved fracture side with the head end of operating table that are elevated to 30 degrees. Standard procedure of delto-pectoral and deltoid splitting approaches were used. Surgical steps involved are as follows:

Fracture reduction was achieved by

- External manoeuvres like traction, adduction and internal rotation of arm.
- Varus impaction of the head was reduced by introducing a periosteal elevator through lateral to the supero-lateral portion of the head on the medial side in order to pull the humeral head in valgus.
- Reduction of the greater and lesser tuberosity's were achieved by pulling them together by non-absorbable sutures passed through the bone tendon junction.
- Reduction was temporarily held by 2mm K-wires.
- Fracture was fixed by proximal humerus locked plates.
- On confirmation of adequate fixation, wound was closed in layers with proper dressing.

Postoperative management

- Postoperatively the limb was immobilised in broad arm sling.
- Operative wound inspection was done on the 2nd, 5th and 8th postoperative days.
- Rehabilitation
 - Sling was advised to be worn at all times.
 - Shoulder pendulum exercises were started from the 3rd day.
 - Patient reported outcome measure (PROM) was started from the 7th day.
 - Active range of motion (AROM) was delayed till 3rd week postoperatively.
 - Cervical, elbow, wrist exercises were encouraged from the day one postoperatively.

Follow up

- Patients were reviewed at 3rd months, 6th months and 1st year.
- Patients were assessed radiographically for the fracture union and functionality by Constant shoulder score.
- Constant score evaluates shoulder function by taking the factors such as pain, arm position, range of movements, activity level and abduction strength into account.

Functional outcome evaluation

Constant scoring technique

The surgical outcome in turn of function was evaluated using European Society for Shoulder and Elbow Surgery (ESSES) adopted the scoring system of Constant and Murley (Constant Murley Scoring (CMS) system). This scoring system of Constant and Murley consists of four variables that are used to assess the function of the shoulder. The right and left shoulders are assessed separately. The subjective variables are pain and ADL (sleep, work, recreation/sport) which give a total of 35

points (pts). The objective variables are range of motion and strength which give a total of 65 pts. Pain: none–15 pts, mild–10 pts, moderate–5 pts, severe–0 pts; activities of daily living: full work –4, full recreation/ sport–4, unaffected sleep –2; forward flexion 10 pts: 0–30–0pts, 31–60–2 pts, 61–90–4 pts, 91–120– 6 pts, 121– 150 –8 pts, 151–180–10 pts. The external rotation 10 pts (hand is not allowed to touch the head): not reaching the head–0; hand behind head with elbow forward–2, hand behind head with elbow back –2, hand on top of head with elbow forward–2, hand on top of head with elbow back–2, Full elevation from on top of head–2. The internal rotation and abduction was also calculated for the range of motion values. Finally, the score was calculated based on: pain–15 pts, activities of daily living–20 pts, range of motion–40 pts, power–25 pts. In total, Constant score are described as follows: 85–100 pts: excellent, 70–85 pts: good, 55–70 pts: fair and less than 55: poor.

Statistical analysis

SPSS software was used to measure the statistical significance between the parameters. The clinical data were expressed as mean. Two way- Anova was used to calculate the p value. P value of less than 0.05 was considered to statistically significant at 95% confidence interval.

RESULTS

The mean age of study population was 56 years (range from 22 to 68 year) with female predominance (n=16, 53.3%). The male population was 46.7% (n=14) which was found to be not statistically significant (p>0.05) from the female population. Age wise distribution showed that the majority of patients were in the range from 51 to 60 yrs (n=12, 40%), 31 to 40 yrs (n=6, 20%), 41 to 50 yrs (n=6, 20%) and other age groups were negligible (20%). The mode of sustained injury happened in 6 patients (20%), 3 patients (10%) and 21 patients (70%) by slip and fall, fall from height and road traffic accident respectively. In our study, 9 patients (30%) were homemakers, 9 patients (30%) were skilled workers, 5 patients (17%) were labourers, 6 patients (17%) were professionals and 1 patient (3%) was student. Higher number of patients reached the hospital between 24 (n=12, 40%) to 48 hours (n=15, 50%) except 3 patients (10%) who reached after 48 hours. In our study, 24 patients (80%) had no pretreatment, 3 patients (10%) had plaster of paris in an unknown centre and 3 patients (10%) had splint (Table 1).

All the patients underwent x-rays but CT scan with 3D reconstruction was done in 14 patients (47%). The majority of fractures in the present study were of Neer’s type 3 part (53.3%) followed by 4 part (46.7%) which was found to be statistically insignificant (p<0.05) (Table 2). Right upper extremity was more commonly involved due to right hand practice by majority of the population. In our study, 1 patient (3%) had associated contralateral

distal radius fracture, 2 patients (7%) had ipsilateral metacarpal fractures, 1 patient (3%) had contralateral metacarpal fracture and 26 patients (87%) had no associated injuries. Larger number of patients (n=22, 73.3%) were operated using delto-pectoral approach than other counterpart (Table 3). Immediate post-operative complications were not encountered in any of the patient. No patient was lost to follow-up. Range of motion evaluation on each follow up revealed good improvement and finally showed excellent result at the final follow-up (Table 4).

Table 1: Type of pretreatment information.

Pretreatment method	No. of patients	%	P value
Splinting	3	10	<0.05*
Plaster of Paris	3	10	
No pretreatment	24	80	

*Statistical significance between total pretreatment population vs. no pretreatment populations.

Table 2: Fracture as per Neers type.

Neers type	No of patients	%	P value
3 part	16	53.3	>0.05 (insignificant)
4 part	14	46.7	

Table 3: Surgical approach details of the study population.

Approach	No of Patients	%	p value
Deltoid splitting	8	26.66	<0.05*
Delto-pectoral	22	73.3	

*Statistical significance.

The functional outcome of deltopectoral approach was excellent in Neers type III primarily followed by type IV but deltoid splitting approach was not found to be ideal in both of the Neers type (p<0.05) (Figure 1). Statistically significant difference existed between the two approaches in relation to functional score but was found to have excellent outcome in patients operated by deltopectoral approach. This could probably be due to the ability to extensively address the tuberosity's reconstruction by deltopectoral approach and the surgeon’s familiarity with the approach. The mean CMS in deltopectoral approach was 80 and 64 in deltoid splitting approach. The bone reunion duration was 12.7 weeks (9 –15 weeks) and based on the surgical approach, deltoid splitting approach was found to have the reunion of bone in shorter duration than delto-pectoral (11.8 weeks vs13 weeks) (Figure 2). Among 30 patients, 27 fractures (90%) had united which was confirmed by radiological and clinical examination (Table 5). The mean CMS at final follow-up was 75.3 which were found to be good. During the follow-up, 3 complications (10%) were encountered in which 1 (3.3%) case had osteonecrosis and Impingement, 1 (3.3%) case had wound infection and 1 (3.3%) case had screw cut-

out. In our study at final follow up in measuring shoulder's range of motion flexion was 132.3, abduction was 112.5, and external rotation was 40.9.

Table 4: Each range of motion parameter showed good improvement in every follow-up.

Follow up	Flexion	Abduction	External rotation	Internal rotation
3 months	91.4	80.2	22.5	W
6 months	114.1	102.8	32.4	W
12 months	132.3	112.5	40.9	D12

Table 5: Each range of motion parameter showed good improvement in every follow-up.

Result	No. of patients	Percentage (%)
Excellent	9	30
Good	12	40
Fair	6	20
Poor	3	10

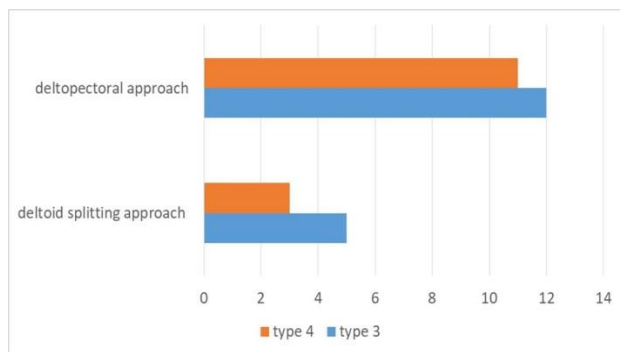


Figure 1: Functional outcome based on surgical approach.

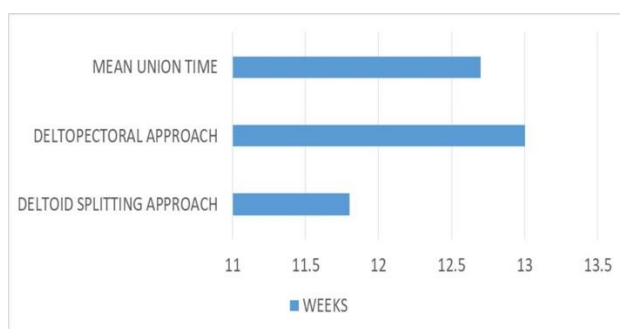


Figure 2: Bone reunion: mean duration and duration based on surgical approach in weeks.

DISCUSSION

In our study, we aimed at evaluating functional and radiological outcome of Neer's type III and IV in proximal humerus fractures treated by locking

compression plate as well to assess the potential complications during the follow-up period.

As the age advance, patients with proximal humerus fractures have been on the rise in the past few decades due to increase in the proportion of population with osteoporosis. Various studies have shown that osteoporosis adversely affects the anchorage of internal fixation and leads to increased failure rates.^{19,20} Patients who have Neer's 3 part or 4 part proximal humerus fractures are more prone for poor clinical results and high failure rates especially when the fixation has been performed with conventional non-locking plates.^{21,22} Sadowski et al demonstrated 100% complications especially in elderly osteoporotic bones like penetration of the proximal screw, screw loosening, subacromian impingement and avascular necrosis of up to 40% with plates.²³

However, locking plates provided better stability than conventional plates which were used in the past. Due to the above, the use of locking plates has currently become the standard protocol for open reduction and internal fixation of proximal humerus fractures especially in the elderly patients with poor bone quality. In the locking plate system, all the forces are transmitted from the bone via the locking head screws to the blade and vice versa. Fixed angle plates enable a gain in the torsional stiffness and stability which promotes a superior outcome and less chance of complications like cut-out of the screws and plates, non-union, avascular necrosis, and fractures distal to the plate.²³ In our study, mean age of the patients was 56 years (range 22 to 68 years) with female predominance (53.3%). Parmaksizoğlu et al studied 32 patients with mean age 63 years and range from 29 to 82 years.²⁵ The mean follow up period in our study was 12 months which coincides with Parmaksizoğlu et al, Piątkowski et al and Moonot et al.²⁵⁻²⁷

We encountered 3 (10%) complications in our study such as 1 case of osteonecrosis and impingement, 1 case of wound infection and 1 case of screw cut-out but did not encounter any cases of non-union, implant breakage. Parmaksizoğlu et al had 1 avascular necrosis with screw penetration; Piątkowski et al had 4 cases of non-union 12 cases of humeral head necrosis 12 and 2 cases of loosening, Moonot et al had 1 case of non-union, 1 case of screw perforation and 1 case of screw loosening in similar to our study.²⁵⁻²⁷ Roderer et al reported the implant related complications (plate impingement, screw perforation, loosening of screw) and were observed in 9 cases (17%).²⁸ In a study conducted by Nourozi et al, had 15% complication rate with 1 case of AVN, 2 case of wound infection and 3 case of malunion.²⁹ Fracture union was assessed radiologically and the average time for union in our study was 12.7 weeks (9 –15 weeks) which was comparable to study conducted by Moonot et al was 10 weeks.²⁷ The average union time in patients operated by deltopectoral was 13 weeks and deltoid splitting was 11.8 weeks. The percentage of total complication

encountered by our study is less or equal to the above reports.

In our study at the final follow-up, 21 patients (70%) had good to excellent score, 6 patients had moderate score, and 3 patients had poor outcome according to CMS system. In Parmaksizoğlu et al study, the mean Constant score of the patients was 79.5.²⁵ The results were excellent in 13 patients (40.6%), good in nine patients (28.1%), fair in eight patients (25%), and poor in two patients (6.3%).²⁴ In Piątkowski et al study, the mean Constant score was 68.9 pts.²⁶ In a study conducted by the Frankhauser et al, the mean Constant score was 74.6 after 12 months.³⁰ Aggarwal et al showed their study CMS result of patients with 17.02% in excellent, 38.3% in good, 34.4% in moderate and 10.6% in poor.³¹ Siwach et al revealed their patients with 28 in excellent, 64% in good, 8 in moderate and nil in poor.³² Bjorkenheim et al demonstrated their patients of 5.5% in excellent, 44.4% in good, 43% in moderate and 6.9% in poor.³³ Mahesh et al illustrated their patients Constant Murley score result population of 15% in excellent, 55% in good, 15% in moderate and 10% in poor.³⁴ But our study had showed the superiority of having more number of patients with 30% in excellent, agreeable no of population of 40% in good with the above studies except Siwach et al and Mahesh et al who showed less number (20%) of population in fair category compared to above study and again comparable Constant Murley score poor population with the above.^{32,34}

Two major approaches have been described for the surgical management of proximal humerus fractures. The delto-pectoral approach is the procedure of choice may not be the best option when performing an angular stable plate fixation of a proximal humerus fracture.^{35,36} It involves substantial soft-tissue dissections, including partial release of the deltoid muscle, retraction of the deltoid muscle and the humeral manipulation to access the lateral aspect of humerus. The current study showed Patients who underwent deltopectoral approach regained better functional outcome than deltoid splitting approach at one year follow up in terms of Constant score and complications. The mean Constant score in deltopectoral approach was 80 and 64 in deltoid splitting approach. In our study at final follow up in measuring shoulder's range of motion flexion was 132.3, abduction was 112.5, and external rotation was 40.9. We had better outcome when compared with Barbosa et al flexion was 103, abduction was 85 and external rotation was 48.36.³⁷

CONCLUSION

Hence, It is concluded that proximal humerus locked compression plate provides an effective method of fixation for comminuted fractures of the proximal humerus. It also provides a stable fixation to permit early mobilization. Patients who underwent deltopectoral approach regained better functional outcome than deltoid splitting approach at one year follow up. Regaining

medial cortical contact and establishing anatomical reductions decreases complication associated with plate fixation. Maximizing the number of screw placement in the humeral head might possibly reduce the loss of reduction and potential hardware complication.

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Ethical approval: The study was approved by the institutional ethics committee

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