

Original Research Article

Functional outcome and incidence of avascular necrosis after two years in four part proximal humeral fractures treated by proximal humerus internal locking system

Akshdeep Singh Bawa*, Rajnish Garg, Pankaj Mahindra, Shekhar Singal, Mohammad Yamin

Department of Orthopaedics, Dayanand Medical College and Hospital, Ludhiana, Punjab, India

Received: 09 September 2016

Revised: 09 September 2016

Accepted: 04 October 2016

*Correspondence:

Dr. Akshdeep Singh Bawa,

E-mail: bawa.akshdeep@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Fractures of proximal humerus are not uncommon, especially in older age groups. In osteoporotic bone requiring open reduction and internal fixation, locking plates offer the advantage of increased pull out resistance of the locking head screws compared with that of conventional screws. The aim of our study was to analyse the functional outcome and incidence of avascular necrosis in four part proximal humeral fractures managed with proximal humerus locking plate.

Methods: It was a retrospective study of patients with NEER's four part proximal humerus fractures treated by proximal humerus locking plate. Patients operated at Dayanand Medical College and Hospital, Ludhiana, Punjab, India from 1st January 2007 to 30th June 2011 was included in the study with a minimum follow up of two years. Scoring system given by Constant et al was used for evaluation of functional outcome and results were graded as Excellent (score 80-100%), good (score 60-79%), fair (constant score 40-59%) or poor (constant score 0-39%).

Results: In present study, a good to excellent result was achieved in 64.2 % patients. A mean constant score of 70.6 points was observed. Only 5.6% of patients had osteonecrosis of humeral head at 2-year follow up.

Conclusions: The importance of early mobilization of the shoulder joint cannot be underestimated in the final outcome of these fractures. We observed better functional outcome in the patients who started early physiotherapy and continued it at home.

Keywords: Functional outcome, Incidence of avascular necrosis, NEER four part fractures, PHILOS

INTRODUCTION

Proximal humeral fractures are now recognized as an increasingly common fracture, accounting for 4-5% of all fractures and 45% of all humeral fractures.¹⁻³ It is the third most common fracture after hip and distal radius fractures, in people above 65 years of age.⁴ According to current projections, every 20th woman at 65 years of age will sustain a fracture of the proximal humerus in her remaining lifetime. A recent trend analysis from Switzerland showed that, between 2000 and 2007, the

absolute number of proximal humeral fractures increased by 22.8% in women and 35.5% in men.^{5,6}

Approximately 85% fractures of the proximal part of the humerus are minimally displaced and assumed to heal well with non-operative treatment.⁷ Around 10-20% of all proximal humeral fractures require open reduction and internal fixation, with goals to achieve fracture stability and allow early mobilization of shoulder. A CT scan is needed for complex four part fractures, however, precise indications for CT in proximal humerus fractures are not

established.⁸ Severe comminution in elderly osteoporotic patients render internal fixation difficult and comminution along the medial cortex leads to varus mal positioning of distal fragments.

An angular stable antegrade locking nail showed better outcome in two or three part fractures, whereas four part fractures showed a poor outcome. Complications were reported like backing out of screws, humeral head screws and pseudoarthrosis.⁹

Shoulder hemiarthroplasty has only been moderately successful and is restricted to displaced fractures of the head involving >40% of the articular surface. Results were poorer in a large subgroup of elderly patients who had undergone this procedure.^{10,11} To overcome all these problems the recently introduced locking plates may allow improved fixation even in osteoporotic bone enabling earlier mobilization and improved outcome.¹²

METHODS

This was a retrospective and prospective study of patients with proximal humeral fractures treated with locked proximal humerus plate. Patients operated at Dayanand Medical College, Ludhiana (a tertiary care referral centre in North India) from 1st January 2007 to 30th June 2011 were included in the study. A Proforma was filled at the time of admission.

Inclusion criteria

Displaced four part proximal humeral fractures

Exclusion criteria

- Undisplaced fractures
- Infection at the fracture site
- Age below 18 years

Fractures were classified using Neer's classification.

Surgical technique

Patient was operated upon using the standard deltopectoral approach. Reduction was provisionally fixed with k wires. Subchondral placement of the screws in the humeral head was confirmed under image intensification in full arc of motion.

Post operatively a shoulder immobilizer supported the arm of the patient. Active shoulder mobilization was started at 6 weeks. Follow up was done at 3 weeks, 12 weeks, 6 months and 1 year. Evaluation of results at 6 months was done on the basis of scoring system given by Constant et al. Results were graded as Excellent (80%-100%), Good (60%-79%), Fair (40%-59%) or Poor (0-39%). Constant and Murley score, the most commonly used method of shoulder functional assessment, consists

of 100 points allotted to pain (15), activities of daily living (20), range of motion (40) and power (25).

RESULTS

A series of 53 cases of proximal humerus fractures treated by locked proximal humerus plating was carried out in the Department of Orthopedics, Dayanand Medical College & Hospital, Ludhiana, Punjab, India from 1st January 2007 to 30th June 2011. The average age in the series was 49.7 years. The age of the patients was in the range of 56 to 87years. Maximum number of fractures were closed (94.4%). There were one fracture each of Gustilo-Anderson grade I, II and III A (1.9% each). There were no Gustilo-Anderson grades IIIB or grade IIIC injury in present study.

Table 1: Distribution of patients according to age (N = 53).

| Age in years | No. of patients | Percentage (%) |
|--------------|-----------------|----------------|
| Up to 20 | 1 | 1.9 |
| 21-30 | 9 | 17 |
| 31-40 | 5 | 9.4 |
| 41-50 | 14 | 26.4 |
| 51-60 | 12 | 22.6 |
| 61-70 | 7 | 13.2 |
| 71-80 | 4 | 7.5 |
| 81-90 | 1 | 1.9 |

Wound infections were seen in 3 patients (superficial in 2 patients and deep in one), impingement and adhesive capsulitis was identified in 4 patients (7.6 %) each. Mal reduction was observed in 6 patients (11.4%), screw perforation in 3 patients (5.7%), plate pullout was seen in 2 patients (3.8 %), broken bit in one patient (1.9 %), while Osteonecrosis of the humeral head was seen in 3 patients (5.7%).

Table 2: Distribution of patients according to post operative complications.

| Complication | No of patients | Percentage |
|-------------------------------------|----------------|------------|
| Wound infections | | |
| Superficial | 2 patient | 3.8 |
| Deep | 1 patient | 1.9 |
| Soft tissue | | |
| Impingement | 4 patients | 7.6 |
| Adhesive capsulitis/frozen shoulder | 4 patients | 7.6 |
| Malreduction | 6 patients | 11.4 |
| screw perforation | 3 patients | 5.7 |
| Distal screw and plate pullout | 2 patients | 3.8 |
| Broken bit | 1 patient | 1.9 |
| AVN | 3 patients | 5.7 |

Table 3: Time to union of fracture.

| Time taken for union | No. of fractures | Percentage (%) |
|----------------------|------------------|----------------|
| < 9 weeks | 2 | 3.7 |
| 9-16 weeks | 48 | 88.9 |
| > 16 weeks | 4 | 7.4 |

Table 3 shows the distribution of patients according to the time to union of fracture. Fracture was termed radiologically united when bridging trabeculi was present across the fracture site covering at least 75% of its circumference. Average time for radiological union was 11.79 weeks. Table 4 shows the distribution of cases according to limitation of occupation or daily living by shoulder. The limitation of occupation was subjective and was assessed according to constant scale. Majority of patients 38 patients (71.7%) had no limitation by shoulder. 6 patients (11.3%) complained of severe limitation.

Table 4: Distribution of cases according to limitation of occupation or daily living.

| Level of limitation | Points | No of patients | Percentage |
|---------------------|--------|----------------|------------|
| No limitation | 4 | 38 | 71.7 |
| Moderate limitation | 2 | 9 | 16.9 |
| Severe limitation | 0 | 6 | 11.3 |



Figure 1: Standard deltopectoral approach.

Table 5: Distribution of cases according to level of painless activity of the arm.

| Level of painless activity | Points | No of patients | Percentage |
|----------------------------|--------|----------------|------------|
| Above head | 10 | 28 | 52.8 |
| Head | 8 | 11 | 20.8 |
| Neck | 6 | 6 | 11.3 |
| Xiphoid | 4 | 4 | 7.5 |
| Waist | 2 | 4 | 7.5 |

Table 5 shows Distribution of cases according to level of painless activity of the arm. More than half of the patients (28 patients, 52.8%) had no pain at “above head” level. 11 patients (20.8%) had painless activity with movements till the head level and 6 (11.3%) had painless range till the neck. However 4 patients (7.5%) had range of abduction only till the xiphoid process or in one case till the waist. Final score of the patients were calculated at the end of 6 months as per constant scoring system, and score was normalized to age and normal shoulder and calculated as normalized constant score. Means constant score was 70.6.

Table 6: Distribution of cases as per constant – Murley scoring system.

| Result | As per constant score | Percentage |
|-----------------------|-----------------------|------------|
| Excellent (80 to 100) | 16 | 30.2 |
| Good (59 to 79) | 18 | 34 |
| Fair (40 to 59) | 10 | 18.9 |
| Poor (0 to 39) | 9 | 17 |



Figure 2: Screw size seen under C arm.



DISCUSSION

Osteoporosis predisposes to low energy fractures having a complex pattern and difficult fixation owing to poor screw purchase. Rate of failure of fixation is also high. In the present study, we had final follow-up of 53 patients (54 proximal humerus fractures) for compilation and analysis.

Present study had more number of young patients with a history of road traffic accident as compared with most of the studies. Patients younger than 50 years of age showed a significantly lower rate of complications than patients more than 50 years of age. Secondary loss of reduction lead to nonunion, humeral head necrosis and implant loosening, especially in elderly patients with diminished bone quality. In our study avascular necrosis was observed in 3 patients (5.7%) all under 50 years of age. But 87.5% of the patients with shoulder stiffness and 100% with implant loosening were more than 45 years of age.

Union, delayed union & non-union

In present study the average time to union was 11.79 weeks. Minimum time to union was 7 weeks and the maximum was 24 weeks. Fracture was termed radiologically united when bridging trabeculi were present across the fracture site covering at least 75% of its circumference.

Thanasas et al in his systematic review of the English and German literature from PubMed database recruited 791 cases of proximal humerus fracture and carried out a study to assess the efficacy and complications related to the use of locked proximal humerus plates. One third of the nonunion cases (4/11) in the pooled results were retrieved from a single study comprising 3-part fractures with severe comminution and diaphysial extensions in younger patients (mean age, 51 years).¹³

A multicentric study of 107 patients by Röderer et al showed uneventful healing of the fracture after three months in 60 cases (57%), after six months in 88 cases (83%), and after 12 months in 103 cases (97%). The remaining fractures (n=3) had not healed after 12 months and showed delayed (n=2) or non-union (n=1). Authors stated that stable reduction was hard to achieve in the weak bone stock and led to high rates of fixation failure.¹⁴ In present study the average time to union of the fracture was 11.79 weeks. There were no cases of nonunion. However there were 4 patients (7.4%) with union delayed as compared to other patients. In one of these patients (1.9%), deep infection developed, which could be the cause for delayed union while in another patient there was severe comminution of the metaphysis up till the proximal mid third junction where a long locked proximal humerus plate had to be used, leading to not a very stable construct.

Range of movement

In the present study, more than half of the patients 27 patients (50.9%) had an abduction of more than 150°. 11 patients (20.8%) each had an abduction of 121°-150° and 61°-90° respectively. 4 patients (11%) had an abduction of 91°-20°. Mean abduction is 137.2° in present study group. 19 patients (35.8%) had a forward flexion of more than 150°. 13 patients (24.6%) each had a forward flexion of 121°-50° and 61°-90° respectively. (8 patients, 15%) had a forward flexion of 91°-20°.

Ricchetti et al in their study of fifty-two patients (54 shoulders) with 2-part (30%), 3-part (56%), and 4-part (14%) had the mean forward elevation for all patients at final follow-up was 130.1°+24.4°, and the mean external rotation was 27.7° + 5.7°.¹⁵

Constant Murley score

In present study the constant score was assessed at a minimum of 6 months follow-up. Our study showed an excellent constant score in 16 patients (30.2%), good result in 18 patients (34%), fair result in 10 patients (18.9%) and poor in 9 patients (17%). Mean constant score is 70.6.

Thalhammer et al retrospectively analyzed functional and radiographic results of 42 patients (average age: 57.8 years) after angular stable plate fixation of proximal humeral fractures. Five patients sustained a 2-part fracture, 24 patients showed a 3-part fracture and thirteen patients were identified with a 4-part fracture. (14 patients, 33%) had an excellent functional outcome, (8 patients, 19%) a good outcome and (14 patients, 33%) had moderate functional results. (6 patients, 14%) had a poor outcome with less than 55% on Constant Score. They experienced a remarkably high rate of technical failures and partial humeral head necrosis, particularly in elderly patients with four-part fractures.¹⁶

Hirschman et al concluded that fracture fixation with the PHILOS was proven to yield good to excellent longer-term results in 75% of their patients.¹⁷ As described in literature, improper placement of the plate can cause damage to the anterolateral branch of the anterior humeral circumflex artery and lead to iatrogenic osteonecrosis. We took C-arm images throughout the arc of rotation of the shoulder joint to avoid this complication.

Screw perforation

In present study of 53 patients, screw perforation was observed in 3 patients (5.7%). The penetrating screws in two patients caused severe limitation of movement and pain. Penetrating screws were removed in these patients, which led to a drastic improvement of their constant score. According to Thanasas et al the most common intraoperative error is incorrect choice of screw length. This complication ranged from 2 to 17.9%. The strategy to purchase as much bone as possible coupled with the spherical shape of the humeral head could be responsible for this complication.¹⁸

Clavert P et al studied specific complications of locking plate fixation of proximal humerus fractures in seventy-three adult patients. The use of locking plate was associated with a high rate of screw cutout (13.7%) that may need revision surgery.¹⁹ Yang et al in their prospective study of 64 consecutive patients treated with a LPHP for an unstable or displaced proximal humerus

fracture had 5 patients in whom screws had penetrated the humeral head. The authors pointed that fracture collapse likely caused many of the cases of screw penetration.²⁰

Malunion

A varus malunion was observed in 4 patients (7.55%) and was found to be the commonest complication in our study. The two patients with implant loosening had the fracture fixed in varus malreduction. Out of the 6 patients with malunion, 4 (66.7%) had a poor final outcome on constant scale, while 2 patients (33.3%) showed moderate outcome. Ricchetti et al in his study of 52 patients had 5 patients with a varus malunion (one 2-part fracture, three 3-part, one 4-part), but none required additional surgery.

Avascular necrosis

Three patients (5.7%) in present study were reported to have developed osteonecrosis of the humeral head. 100% of the cases with avascular necrosis were displaced four part fractures. 2 patients (67%) with AVN had a history of domestic fall while one patient (33%) had a road traffic accident. All patients were males in the 5th decade of their life. Implant was removed in one patient with severe pain in his operated shoulder. This patient was the one with loosening of the implant.

After removal of implant this patient is able to perform his activities of daily living to a decent level. Hertel et al evaluated risk factors for humeral head ischemia following intracapsular proximal humerus fracture and found that the most relevant predictors were the length of the dorsomedial metaphyseal extension (<8 mm), the integrity of the medial hinge (defined by greater than 2-mm shaft displacement in any direction), and fracture with an anatomic neck component. When all 3 of these criteria were present, the positive predictive value for ischemia was 97%.

Out of 53 patients in our study, 3 patients (5.7%) developed osteonecrosis of the humeral head. All the 3 patients suffered a displaced four part fracture. 2 patients (75%) of the 3 patients had a poor constant score at 6 months follow-up.

CONCLUSION

The importance of early mobilization of the shoulder joint cannot be underestimated in the final outcome of these fractures. We observed better functional outcome in the patients who started early physiotherapy and continued it at home.

Following the principles of locking plate fixation we can achieve a stable osteosynthesis and start early mobilization even in severely osteoporotic comminuted fractures. Thus we recommend locking proximal humerus

plates for the treatment of three and four part fractures of the proximal humerus.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Instrum K, Fennell C, Shrive N, Damson E, Sonnabend D, Hollinshead R. Semitubular blade plate fixation in proximal humeral fractures: a biomechanical study in a cadaveric model. *J Shoulder Elbow Surg.* 1998;7:462-6.
2. Palvanen M, Kannus P, Niemi S, Parkkari J. Update in the epidemiology of proximal humeral fractures. *Clin Orthop.* 2006;442:87-92.
3. Spence RJ. Fractures of the proximal humerus. *Curr Opin Orthop.* 2003;14:269-80.
4. Baron JA, Barrett JA, Karagas MR. The epidemiology of peripheral fractures. 1996;18(3 suppl):209S-13s.
5. Barrett JA, Baron JA, Karagas MR, Beach ML. Fracture risk in the U.S. Medicare population. *J Clin Epidemiol.* 1999;52:243-9.
6. Hanson B, Neidenbach P, de Boer P, Stengel D. Functional outcomes after nonoperative management of fractures of the proximal humerus. *J Shoulder Elbow Surg.* 2009;18(4):612-21.
7. Marie-Jeanne VPTF, Kastelein GW, Breslau PJ. Proximal Humerus Fractures. A Prospective Study of the Functional Outcome after Conservative Treatment. *Eur. J. Trauma.* 2001;27:133-6.
8. Brunner F, Sommer C, Bahrs C, Heuwinkel R, Hafner C, Rillmann P, et al. Open reduction and internal fixation of proximal humerus fractures using a proximal humeral locked plate: a prospective multicenter analysis. *J Orthop Trauma* 2009;23(3):163-72.
9. Fakler JK, Hogan C, Heyde CE, John T. Current concepts in the treatment of proximal humeral fractures. *Orthopedics.* 2008;31(1):42-51.
10. Nho SJ, Brophy RH, Barker JU, Cornell CN, MacGillivray JD. Management of proximal humeral fractures based on current literature. *J Bone Joint Surg Am.* 2007;89 Suppl 3:44-58.
11. Ricchetti ET, Warrender WJ, Abboud JA. Use of locking plates in the treatment of proximal humerus fractures. *J Shoulder Elbow Surg.* 2010;19(2 Suppl):66-75.
12. Sharafeldin KN, Quinlan JF, Corrigan J, Kelly IP. Functional follow-up of locking plate fixation of fractures of the proximal humerus. *Eur J Orthop Surg Traumatol.* 2008;18:87-92.
13. Röderer G, Erhardt J, Kuster M, Vegt P, Bahrs C, Kinzl L, Gebhard F. Second generation locked plating of proximal humerus fractures--a prospective multicentre observational study. *Int Orthop.* 2011;35(3):425-32.

14. Ricchetti ET, Warrender WJ, Abboud JA. Use of locking plates in the treatment of proximal humerus fractures. *J Shoulder Elbow Surg.* 2010;19(2 Suppl):66-75.
15. Thalhammer G, Platzer P, Oberleitner G, Fialka C, Greitbauer M, Vécsei V. Angular stable fixation of proximal humeral fractures. *J Trauma.* 2009;66(1):204-10.
16. Hirschmann MT, Fallegger B, Amsler F, Regazzoni P, Gross T. Clinical longer-term results after internal fixation of proximal humerus fractures with a locking compression plate (PHILOS). *J Orthop Trauma.* 2011;25(5):286-93.
17. Thanasis C, Kontakis G, Angoules A, Limb D, Giannoudis P. Treatment of proximal humerus fractures with locking plates: a systematic review. *J Shoulder Elbow Surg.* 2009;18(6):837-44.
18. Clavert P, Adam P, Bevort A, Bonnomet F, Kempf JF. Pitfalls and complications with locking plate for proximal humerus fracture. *J Shoulder Elbow Surg.* 2010;19(4):489-94.
19. Yang H, Li Z, Zhou F, Wang D, Zhong B. A prospective clinical study of proximal humerus fractures treated with a locking proximal humerus plate. *J Orthop Trauma.* 2011;25(1):11-7.
20. Lill H, Bewer A, Korner J, Verheyden P, Hepp P, Krautheim I, Josten C. Conservative treatment of dislocated proximal humeral fractures. *Zentralbl Chir.* 2001;126(3):205-10.
21. Hertel R. Fractures of the proximal humerus in osteoporotic bone. *Osteoporosis Int.* 2005;16:565-72.

Cite this article as: Bawa AS, Garg R, Mahindra P, Singal S, Yamin M. Functional outcome and incidence of avascular necrosis after two years in four part proximal humeral fractures treated by proximal humerus internal locking system. *Int J Res Med Sci* 2016;4:4979-84.