

Functional Outcome Analysis of Prosthetic Replacement of Comminuted, Displaced Proximal Humerus Fractures in Elderly Individuals: A Prospective Observational Study

Muthu Vignesh¹, Avinash Manoharan², Maheswaran Jawaharlal Nehru³

¹Assistant Professor, Department of Orthopaedics, Government Theni Medical College Hospital, Tamil Nadu, India

²Assistant Surgeon, Department of Orthopaedics, Government Medical College, Virudhunagar, Tamil Nadu, India

³Associate Professor, Department of Orthopaedics, Government Medical College, Virudhunagar, Tamil Nadu, India

Received: 29-12-2022 / Revised: 12-01-2023 / Accepted: 10-02-2023

Corresponding author: Dr Maheswaran Jawaharlal Nehru

Conflict of interest: Nil

Abstract

Introduction: Proximal humeral fractures are observed commonly among the elderly population, especially women. Almost half of these fractures occur at home, majorly after falls. Recently replacement of the fractured head or hemiarthroplasty (HA) of the shoulder for displaced comminuted proximal humeral fractures has shown promising results with better acceptance when compared to ORIF.

Aims and Objectives: To assess the functional outcome of prosthetic replacement of comminuted, displaced proximal humerus fractures in elderly individuals.

Methods: Design: Prospective observational type. **Study duration:** Two years. **Study tool:** Using a semi-structured pre-tested tool that included Constant Murley scores for functional outcomes. Data was collected using datasheets and entered in Microsoft Excel and analyzed using SPSS version 20. The comparison of Constant Murley scores was compared between the Neer's III and IV parts across the follow-up months. A p-value of less than <0.05 was considered statistically significant.

Results: We included around 20 patients who had Neer's III and IV class of proximal humerus fractures. The majority of our study participants were males, belonging to 60-70 years age group. We observe that almost 90% of the study participants recovered well without any post-operative complications. We observed that the distribution of raw Constant Murley scores was statistically different between the class of fractures, at the first third and eighth month of follow-up respectively. Whereas in the first year and second year of follow up we did not find any statistically significant difference.

Conclusion: Hemiarthroplasty can be considered as a vital option of comminuted, displaced proximal humerus fractures among elderly individuals.

Keywords: Fractures, Humerus, Hemiarthroplasty, Functional Outcome, Constant score, Elderly, Postoperative complications, Displaced fractures, Constant Murley score.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

In general, proximal humeral fractures are termed as fractures at the surgical neck of the humerus or proximal to it. It affects commonly the elderly population of above 75 years, especially women [1]. It is now regarded as the second most encountered upper extremity fracture over 60 years of age, followed by nonvertebral osteoporotic fractures and distal radius fractures. Recently there is an increase in the incidence, of about 40% every 5 years after their 4th decade among females and 6th decade among males respectively. Almost half of these fractures occur at home, majorly after falls [2]. The main mechanisms behind proximal humerus fractures are owing to i) bending forces exerted at the surgical neck ii) Glenoid's compressive loading in the head of humerus iii) the tension forces exerted on the tuberosities by the rotator cuff. Such fractures other than causing pain and discomfort for the elderly also results in poor quality of life [3].

These fractures can be classified into a 3- or 4-part fracture namely: non-displaced, displaced or displaced with dislocation (which can further be classified as types A, B and C) [4]. Non-operative treatment remains the mainstay of management as the majority of the cases are either nondisplaced or minimally displaced. Fracture stability, assessed by radiographical methods and clinical examination, plays a vital role in determining the management. Open Reduction and Internal Fixation (ORIF) remains the most performed surgical procedure for proximal fracture humerus. However, in the case of depressed fractures or comminuted fractures involving >40% of the articular surface are often non-reconstructable [5,6].

Recently replacement of the fractured head or hemiarthroplasty (HA) of the shoulder has shown promising results with better acceptance when compared to ORIF for such

fractures. The success of this procedure depends on the condition of the rotator cuff and the degree of non-union. Perhaps it is noted that majority of the elderly individuals experiencing such fractures have poor rotator cuff morphology. Recent studies have shown that prosthetic replacement has convincing results among elderly individuals with comminuted or displaced fractures. Thus we did a study with a aim of assessing the functional outcome of prosthetic replacement of comminuted, displaced proximal humerus fractures in elderly individuals [7-9].

Methods

Study design, setting and participants

We did our study as a prospective observational type, where we selected 20 patients conveniently with the inclusion criteria age more than 55 years, Neer's (III and IV) part fractures & Neer's (III and IV) part fracture-dislocations admitted to the Department of Orthopaedics, Govt Rajaji Hospital, Madurai, Tamil Nadu. We excluded patients having compound fractures and who had neurological comorbidities. We did this study over a period of 2 years (Jan 2019- 2020).

Study tool

We collected data using a semi-structured pre-tested questionnaire which included 4 domains i) demographic details ii) examination details and radiological findings ii) pre-operative assessment and iv) post-operative assessment. We collected clinical details and radiological investigations including x rays.

Study procedure

The pre-operative evaluation among the patients included a full clinical examination of the extremity including neurovascular status, investigation profile, X-ray (anteroposterior, axial view, and scapular view), CT with 3D reconstruction of the

affected shoulder. All patients were operated under regional or general anaesthesia depending on the clinical status with a beach chair position with arm by side. We opted for a delto-pectoral approach, advancing through the delto-pectoral groove along with the lateral reflection of the cephalic vein. Once the subdeltoid space is identified from the delto-pectoral interval, depending on the duration of injury, presence of fracture hematoma and formation of scar tissue further soft tissue management is planned. Once the tuberosities were identified, we used 1-0 polyester sutures to retract the tendon-bone junction. A prosthetic head was matched based on the humeral head and the shaft was prepared for the implantation of the stem. PMMA bone cement was used to fix the stems. Once the medullary cavity was fixed with absorbable blocker bone cement (Refobacin-Palacos⁰, Heraeus, Hanau, Germany) was placed using a gun, followed by insertion of the prosthesis. Drain removal was done on the 2nd post-operative day, with suture removal between 12-15th postoperative days. Pendular exercises were encouraged in the 4th week and overhead abduction by the 6th week. Daily follow up was done up to 15 days, and monthly follow up thereafter using X-rays and CONSTANT score up to 2 years. The CONSTANT shoulder scores consisted of 8 parameters namely pain, arm positioning, external rotation, forward flexion, the strength of

abduction, internal rotation, activity check, and lateral elevation. The total scores ranged from 0 to 100.

Statistical Analysis

Data was collected using datasheets and entered into Microsoft Excel and analyzed using SPSS version 20. Continuous variables were summarized as mean (SD) or median (IQR) based on normality. Categorical variables were summarized as frequency and proportions. The comparison of CONSTANT scores was compared between the Neer's III and IV parts across the follow-up months. The scores can be further categorized into >30 as poor, 21-30 fair, 11-20 good, and <11 as excellent. A p-value of less than <0.05 was considered statistically significant.

Results

We enrolled a total of 20 cases who had comminuted and or displaced proximal humerus fractures. Everyone agreed to participate in the study and everyone was followed up for the period of 2 years with no loss to follow up. We observed that majority of our study participants were belonging to the 60-70 age group, with almost equal representation of both genders, around 55% had a right-sided injury, while 60% constituted Neer's IV part fracture. Around 55% had accidental fall as the mode of injury (Table 1)

Table 1: Study characteristics of the study participants (N=20)

Characteristics	Frequency (%)
Age group	
50-60 years	5 (25.0)
60-70 years	11 (55.5)
>80 years	4 (20.0)
Sex	
Female	8 (40)
Male	12 (60)
Side of injury	
Left	9 (45)

Right	11 (55)
Type of fracture	
3 parts	8 (40)
4 parts	12 (60)
Mode of injury	
Accidental fall	11 (55)
RTA	9 (45)

Table 2 explains the distribution of postoperative complications among the study participants. We observe that almost 90% of the study participants recovered well without any post-operative complications while two of them had an infection as their follow-up complication. Only one patient reported to have paresthesia following the surgery

Table 2: Follow up characteristics of the study participants (N=20)

Post-operative complications	
Absent	18 (90)
Present (Infections)	2 (10)
Paresthesia	
Absent	19 (95)
Present	1 (5)

Table 3: Association between Constant score categories among the Neer's classification through the follow up period. (N=20)

CONSTANT score	Categories	3 parts, N (%)	4 parts, N (%)	P value
Preoperative score	Poor	8 (100)	12 (100)	0.12
	Good	2 (25)	3 (25)	
	Fair	6 (75)	9 (75)	
at 3rd month	Good	7 (87.5)	4 (33.3)	0.028*
	Fair	1 (12.5)	8 (66.7)	
at 6th month	Good	8 (100)	8 (66.7)	0.117
	Fair	0 (0)	4 (33)	
at 1yr	Very Good	1 (12.5)	0 (0)	0.241
	Good	7 (87.5)	10 (83.3)	
	Fair	0 (0)	2 (16.7)	
at 2yrs ^a	Very Good	2 (25)	0 (0)	0.112
	Good	6 (75)	10 (83.3)	
	Fair	0 (0)	2 (16.7)	

We observe that there was no significant difference with respect to their distribution of constant scores between the three and four-part fractures pre-operatively. Comparing the categorization of constant scores during the follow-up period showed that there was a significant difference with respect to the distribution of scores between the three and four parts fracture at the following month, (P value < 0.05). While all other follow-up periods showed that there was no statistical association with respect to the distribution of scores between the Neer's III and IV part fractures (P value > 0.05) (Table 3)

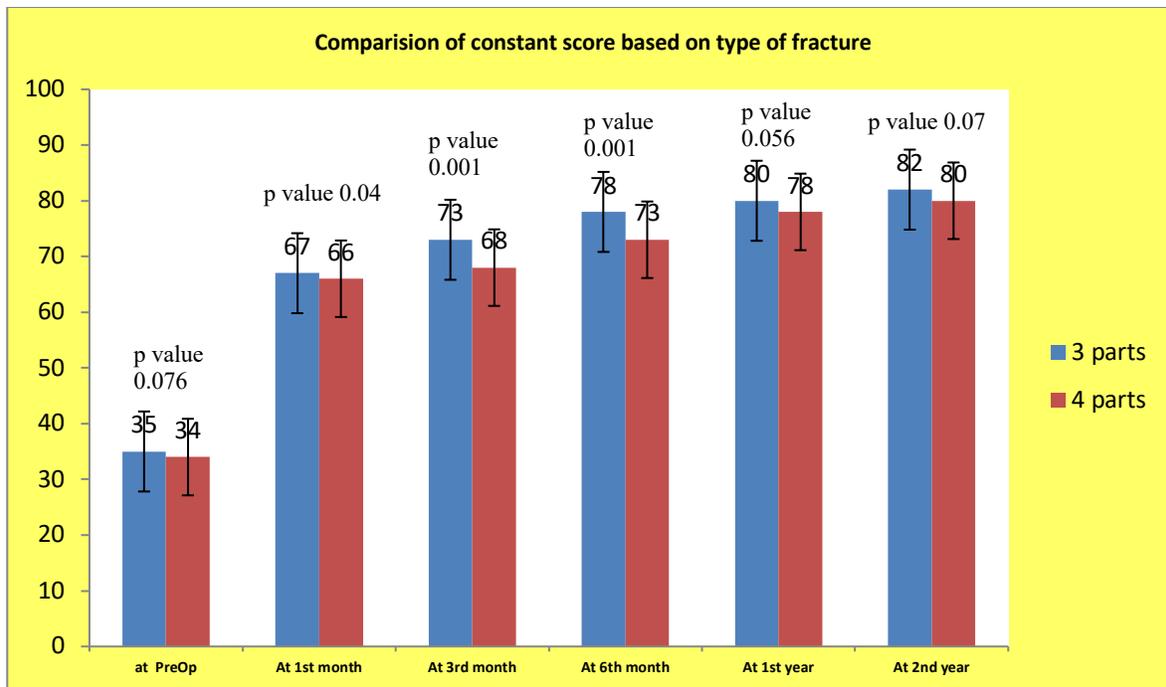


Figure 1: Distribution of constant scores between the Neer's III and IV part fractures during follow up

Fig 1 explains the distribution of raw constant scores between the Neer's III and IV part fractures during follow up. We observed that the distribution of raw scores was not statistically significant preoperatively, while there was a statistically significant difference in the distribution of constant scores at the first third and eighth month of follow-up respectively. Whereas at the first year and second year of follow up we did not find any statistically significant difference.

Discussion

Taking into account of the limited clinical studies documenting the various treatment modalities available for comminuted proximal humerus fractures, there is no single type of surgical intervention that causes complete cure but is considered superior to nonsurgical treatment in improving functional outcomes [10]. Hemiarthroplasty is still regarded as one of the best operative options for comminuted, displaced proximal humerus fractures, that are mainly non-reconstructable. Many studies have reported that Hemi-arthroplasty surgeries can reduce the pain and suffering of the individuals who had sustained proximal humerus fractures which have resulted in increased quality of life among them during their follow-up period [11,12]. Despite this evidence, there

are a few studies that have questioned the long-term effectiveness as some patients have shown only good to fair results with respect to pain control and resumption to activities of daily living [13,14].

With respect to the forward elevation following hemiarthroplasty of humerus fractures, it ranges between 20 to 180° with an average of 110°. Despite several studies showing varied results, hemiarthroplasty has constantly shown very low prosthetic revision rates with a high survival rate of about 97% at the end of one year of follow-up, 95 % at 5 years, and around 94 % by the end of 10 years of follow-up. Perhaps a few studies showed that the functional outcomes of more than 50% of the patients remained

unsatisfactory by the end of 10 median years of follow-up [15].

Our study showed that the distribution of complications following Hemiarthroplasty was very low. This finding was again found to be similar to a study done by Gierer *et al* who also reported minor complications following hemiarthroplasty [16]. Studies specifically randomized controlled trials comparing open reduction and internal fixation with hemiarthroplasty have shown varying results with respect to the final outcome. A study done by Boyle *et al* has shown that both these operating procedures give comparable results for acute fractures [17]. Certain studies have shown that hemiarthroplasty is better when compared to open reduction and internal fixation thereby resulting in better functional outcomes among the elderly [18,19].

In our study, we found the distribution of raw constant scores between the Neer's III and IV part fractures during follow up was statistically different during the post operative intervals first, the third and eighth month of follow-up respectively. Whereas at the first year and second year of follow up we did not find any statistically significant difference. Similar results we observed from various other prospective studies done from varied clinical settings, which also showed a significant difference with respect to the Murray constant scores during the time period of follow ups across the Neer's groups [14,20].

Study done by Gadea *et al* have documented that open reduction and internal fixation had lesser constant scores when compared to hemiarthroplasty cases during the one-year period of follow-up. (18) But interestingly it was observed that avascular necrosis of the humerus head was a significant determinant of the functional outcome [21,22]. Among cases operated by open reduction and internal fixation where it was noted that patients with

avascular necrosis of the head of the humerus had lower constant scores when compared to cases who had no avascular necrosis and had results comparable with hemiarthroplasty [23,24]. A few studies have reported that during the long-term follow-up of cases, complications such as non-union was reported in around 1/5 of the cases, followed by infection and paresthesia [25]. Studies have even reported infection rates can be as high as 8%, while a few studies have interestingly reported that heterotopic ossification can occur in about 8-9% of cases but does not result in limitation of functions [26]. This finding contrasted with our study findings as our study reported much lower complication rates; this could be due to differences in patient characteristics, comorbidity pattern, and incidence of intraoperative complications among the studies. The development of newer prosthetic designs such as 4th generation EPOCA-C.O.S.-humeral head prosthesis with reconstruction exactly fitting the anatomical configuration is on a rise. In accordance with this nowadays primary prosthetic replacement of the comminuted humeral head is gaining importance.

Conclusion and Recommendations

Through our study, we conclude that despite the development of new implants, the management of comminuted proximal humerus fractures poses a huge challenge for the operating surgeon, owing to factors such as osteoporosis and subsequent implant failure. In these cases, prosthetic replacement using hemiarthroplasty serves as a vital treatment option with the advantage of lesser incidence of complications, lesser blood loss and reduced incidence of secondary revision surgeries. Thus, we recommend the use of hemiarthroplasty for shattered humeral head fractures specifically among the elderly for early functional recovery and good quality of life.

References

1. Kannus, P., Palvanen, M., Niemi, S., Parkkari, J., Jarvinen, M, Vuori, I. Osteoporotic Fractures of the Proximal Humerus in Elderly Finnish Persons: Sharp Increase in 1970-1998 and Alarming Projections for the New Millennium. *Acta Orthopaed Scand*. 2003; 71: 465-470
2. Granacher, U., Muehlbauer, T., Gschwind, Y.J., Pfenninger, B. Kressig, R.W. Assessment and Training of Strength and Balance for Fall Prevention in the Elderly: Recommendations of an Interdisciplinary Expert Panel. *Zeitschrift für Gerontologie + Geriatrie*. 2014;47: 513-526
3. Hodgson S. Proximal humerus fracture rehabilitation. *Clin Orthop Relat Res*. 2006;442:131–138.
4. Court-Brown CM, Garg A, McQueen MM. The epidemiology of proximal humeral fractures. *Acta Orthop Scand*. 2001;72(4):365–371.
5. Hertel R, Hempfing A, Stiehler M, Leunig M. Predictors of humeral head ischemia after intracapsular fracture of the proximal humerus. *J Shoulder Elbow Surg*. 2004;13(4):427–433.
6. 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;89:44–58.
7. Kralinger F, Schwaiger R, Wambacher M, Farell E, Menth-Chiari W, Lajtai G, et al. Outcome after primary hemiarthroplasty for fracture of the head of the humerus. *J Bone Joint Surg (Br)* 2004;86(2):217–219
8. Olerud P, Ahrengart L, Ponzer S, Saving J, Tidermark J. Internal fixation versus nonoperative treatment of displaced 3-part proximal humeral fractures in elderly patients: a randomized controlled trial. *J Shoulder Elbow Surg*. 2011;20(5):747–755.
9. Robinson CM, Amin AK, Godley KC, Murray IR, White TO. Modern perspectives of open reduction and plate fixation of proximal humerus fractures. *J Orthop Trauma*. 2011;25(10):618–629.
10. Handoll, H.H., Keding, A., Corbacho, B., Brealey, S.D., Hewitt, C. Rangan, A. Five-Year Follow-Up Results of the PROFHER Trial Comparing Operative and Non-Operative Treatment of Adults with a Displaced Fracture of the Proximal Humerus. *Bone Joint J*. 2017; 99: 383-392
11. Péus, D., Newcomb, N. and Hofer, S. Appraisal of the Karnofsky Performance Status and Proposal of a Simple Algorithmic System for Its Evaluation. *BMC Med Informat Decision Making*. 2013;13(72)
12. Kirchhoff C, Biberthaler P. Indication for primary fracture prosthesis of the shoulder. *Der Unfallchirurg*. 2013 Nov 1;116(11):1015-29
13. Murray IR, Amin AK, White TO, Robinson CM. Proximal humeral fractures: current concepts in classification, treatment and outcomes. *J Bone Joint Surgery*. 2011 Jan;93(1):1-1.
14. Cuff DJ, Pupello DR. Comparison of hemiarthroplasty and reverse shoulder arthroplasty for the treatment of proximal humeral fractures in elderly patients. *J Bone Joint Surgery*. 2013 Nov 20;95(22):2050-5.
15. Crooks V, Waller S, Smith T, Hahn TJ. The use of the Karnofsky Performance Scale in determining outcomes and risk in geriatric outpatients. *J Gerontol*. 1991 Jul 1;46(4):M139-44.
16. Gierer P, Simon C, Gradl G, Ewert A, Vasarhelyi A, Beck M, Mittlmeier T. Complex proximal humerus fractures--management with a humeral head prosthesis? Clinical and radiological

- results of a prospective study. *Der Orthop.* 2006 Aug 1;35(8):834-40.
17. Boyle MJ, Youn SM, Frampton CM, Ball CM: Functional outcomes of reverse shoulder arthroplasty compared with hemiarthroplasty for acute proximal humeral fractures. *J Shoulder Elbow Surg* 2012. [Epub ahead of print]
 18. Gadea F, Alami G, Pape G, Boileau P, Favard L: Shoulder hemiarthroplasty: Outcomes and long-term survival analysis according to etiology. *Orthop Traumatol Surg Res* 2012. [Epub ahead of print]
 19. Sirveaux F, Navez G, Roche O, Molé D, Williams MD. Reverse prosthesis for proximal humerus fracture, technique and results. *Tech Shoulder Elbow Surg.* 2008;9:15–22.
 20. Tauber M, Magosch P, Habermeyer P. Humeral head replacement in acute proximal humerus fractures. *Der Unfallchirurg.* 2013 Aug 1;116(8):691-7.
 21. Solberg BD, Moon CN, Franco DP, Paiement GD. Locked plating of 3-and 4-part proximal humerus fractures in older patients: the effect of initial fracture pattern on outcome. *J Orthop Trauma.* 2009 Feb 1;23(2):113-9.
 22. Choo A, Sobol G, Maltenfort M, Getz C, Abboud J. Prevalence of rotator cuff tears in operative proximal humerus fractures. *Orthop.* 2014 Nov 1;37(11):e968-74.
 23. Wang J, Zhu Y, Zhang F, Chen W, Tian Y, Zhang Y. Meta-analysis suggests that reverse shoulder arthroplasty in proximal humerus fractures is a better option than hemiarthroplasty in the elderly. *International orthopaedics.* 2016 Mar;40(3):531-9.
 24. Sowa B, Thierjung H, Bühlhoff M, Loew M, Zeifang F, Bruckner T, et al. Functional results of hemi-and total shoulder arthroplasty according to diagnosis and patient age at surgery. *Acta orthop* 2017 May 4;88(3):310-4.
 25. Lin DJ, Wong TT, Kazam JK. Shoulder arthroplasty, from indications to complications: what the radiologist needs to know. *Radiograph.* 2016 Jan;36(1):192-208.
 26. Aldinger PR, Raiss P, Rickert M, Loew M. Complications in shoulder arthroplasty: an analysis of 485 cases. *Int orthop.* 2010 Apr;34(4):517-24.