Original Research Article

Study of Functional outcome of three or four part proximal humerus fracture treated with primary hemiarthroplasty

Abstract

Introduction: Proximal humerus fracture comprises 4–5% of all fractures.The treatment of displaced proximal humerus fracture is controversial. It varies from conservative to surgical management. Primary hemiarthroplasty in proximal humerus fracture is indicated in three or four part fracture or fracture dislocations. Main aims of treatment in ORIF are preservation of vascularity of humeral head and an anatomical reduction of fracture, which is difficult in three or four part fractures of proximal humerus. Hence we studied functional outcome of 3 or 4 part proximal humerus fracture treated with primary hemiarthroplasty.

Materials and Methods: 15 patients diagnosed with three or four part proximal humerus fracture underwent primary hemiarthroplasty between January 2017 and June 2018. Functional evaluation based on constant score and radiological assessments by periodic X-rays were done. All patients were operated in a 'beach chair position'. The lesser and greater tuberosities were dissected with their tendinous attachments and were later reattached to the proximal humerus for stability of the prosthesis.

Results: Mean follow up was 14.3 months (range 11-18 months). Mean age was 61.20 years (range 48–78 years). Ten patients were male and five were female. Mean Constant score was 55.25 (range 43.2-64.4) points at final follow up. . Mean anterior elevation was 119.5°(range 75^0-150^0). Mean active abduction was 104° (range 57° - 130°). Mean external rotation was 24° (range 16° - 30°). Proximal migration of tuberosity was present in two patients. Two patients had moderate pain at their final follow up. Twelve (i.e., 80%) patients were satisfied about their functional outcome.

Conclusion: The study showed hemiarthroplasty is a better option in treating

proximal humerus fracture in elderly but also is a viable alternative to osteosynthesis for grossly comminuted proximal humerus fractures in young adults.

Key Words: Proximal humerus fracture, primary hemiarthroplasty, tuberosity healing.

Introduction

Proximal humerus fracture comprises 4–5% of all fractures.[1] Typically occurs in a bimodal distribution in older women as a result of low-energy falls or in younger men as a result of high-energy trauma. [2,3] The treatment of displaced proximal humerus fracture is controversial. It varies from conservative to surgical management. With continued advancement in techniques and implants surgical fixation of proximal humerus is gaining popularity. Surgical management includes close reduction and percutaneous pinning, open reduction, and internal fixation with locking compression proximal humerus plate and hemiarthroplasty.[4] However, complication rates are still high in humeral head preserving procedures. In particular, osteonecrosis of humeral head remains unchanged even with the most modern of techniques. Thus main aim of treatment with ORIF are preservation of vascularity of humeral head, an anatomical reduction of fracture, and good functional outcome of the shoulder which is difficult to achieve in three and four part fractures of proximal humerus. Hence nowadays Primarily shoulder hemiarthroplasty is indicated in patients with grossly displaced three and four part fractures or fracture dislocations, split head fractures, impacted fractures with loss of over 40% articular surface, and anatomical neck fractures of proximal humerus where more chances of osteonecrosis are present.[5-8] Neer had described good and satisfactory results after primary shoulder hemiarthroplasty in displaced three and four part fractures.[9] Initially first generation monoblock prostheses were used by Neer in 1970[9] then replaced by second generation modular prostheses which provided better soft tissue balancing and good range of motion. Third generation prostheses were introduced in 1991 recreating

anatomy of proximal humerus more accurately and hence more adaptable to the individual bony anatomy.[10,11] Post operatively Success of shoulder hemiarthroplasty depends on soft tissue integrity with reattachment of the tuberosities, bone quality, glenoid bone stock, stem height, version of the prosthesis, and soft tissue balancing. Hence we want to study the functional outcome of three or four part proximal humerus fracture treated with primary hemiarthroplasty and to compare the results with other similar published studies.

Materials and Methods

15 patients diagnosed with three or four part proximal humerus fracture (graded according to Neer's classification) based on antero-posterior and oblique radiographs of the shoulder (Fig. 1) underwent primary hemiarthroplasty between January 2017 and June 2018 at KIMS (Krishna Institute of Medical Sciences)hospital were included in this study. If there was difficulty in obtaining the axillary view due to a patient's pain or apprehension, a modified axillary view such as a Velpeau view can be obtained, allowing the patient to remain comfortable in a sling. Neer classification system of Proximal Humerus Fracture is based on the anatomical relationship of four segments: humeral shaft, Greater tuberosity, Lesser tuberosity, head with articular surface. Each segment is considered as separate part in the fracture if there is more than 1cm of displacement or 45° of angulation .[12] Although the Neer classification has demonstrated poor inter and intra-observer reliability, it is still commonly used, due to its simplicity.[13] All patients had acute injuries and were operated within 10 days of injury. Computed tomography (CT) scan with 3-D reconstruction (Fig. 2) was done in all patients which helped in planning the surgical management. For preoperative planning of arthroplasty, an AP view of the contralateral humerus is used to template the planned length and height of the implant. Patients were discharged on post-operative day 5 and followed up on outdoor basis and were assessed according to a predetermined Score. Clinical and functional assessments were done by Constant score.[14] Constant score consists of 0–100 points for single shoulder. It is divided into subjective and objective components. Subjective

component consists of pain (15 points) and activities of daily living (sleep, work, and recreation/sports activities) (20 points). Objective component consists of a range of motion (40 points) and power of muscles (25 points) around shoulder. Patients were followed postoperatively at 2 week (at the time of suture removal), 6 week then monthly for next 3 months, and then 3 monthly till the last follow-up till radiological bony union of the tuberosities was seen. Radiological assessment was done with X-rays of shoulder in antero-posterior and axial views, if possible and X-rays were evaluated to assess tuberosity position and its bony union with the proximal humerus, any resorption of tuberosity, distance of top of the humeral head from acromion, and development of radiolucency at bone cement interface. Postoperative infection and loosening of implant were also recorded. For postoperative infection, assessment of wound healing, implant exposed, discharge from operative site, blood parameters like complete blood count was done. For loosening of implants, serial radiographs were assessed to see any signs of radiolucency at bone cement interphase.

CASE 1:

Fig. 01: Pre-operative radiograph and CT scan of proximal humerus fracture

Fig. 02: Pre-operative 3-D reconstruction CT scan of Proximal humerus fracture

CASE 2:

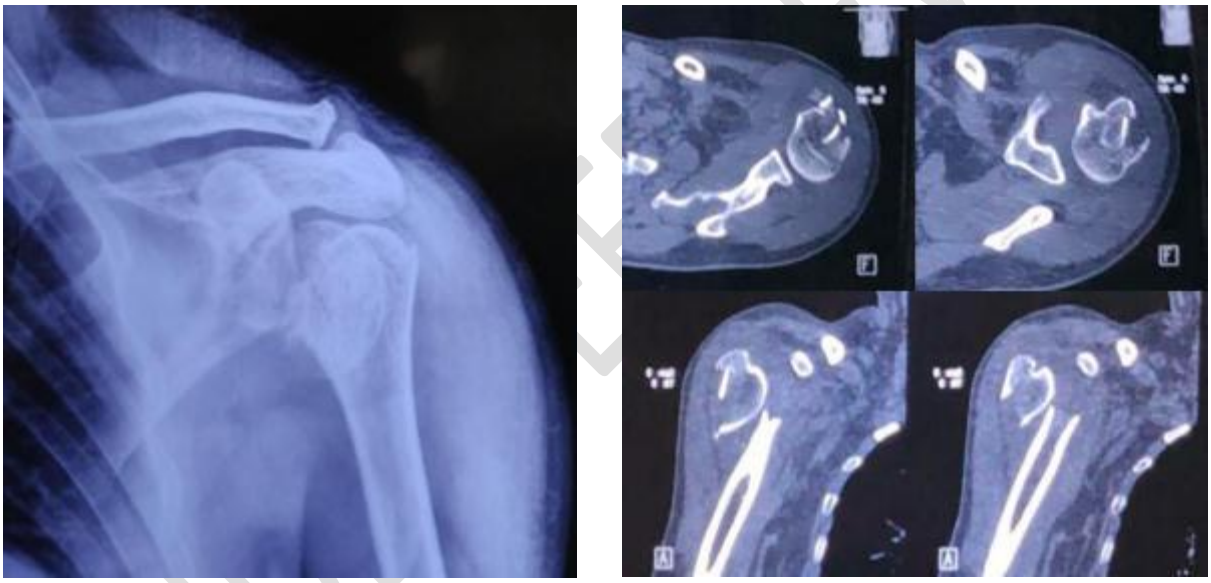


Fig. 03: Pre-operative radiograph and CT scan of a proximal humerus fracture

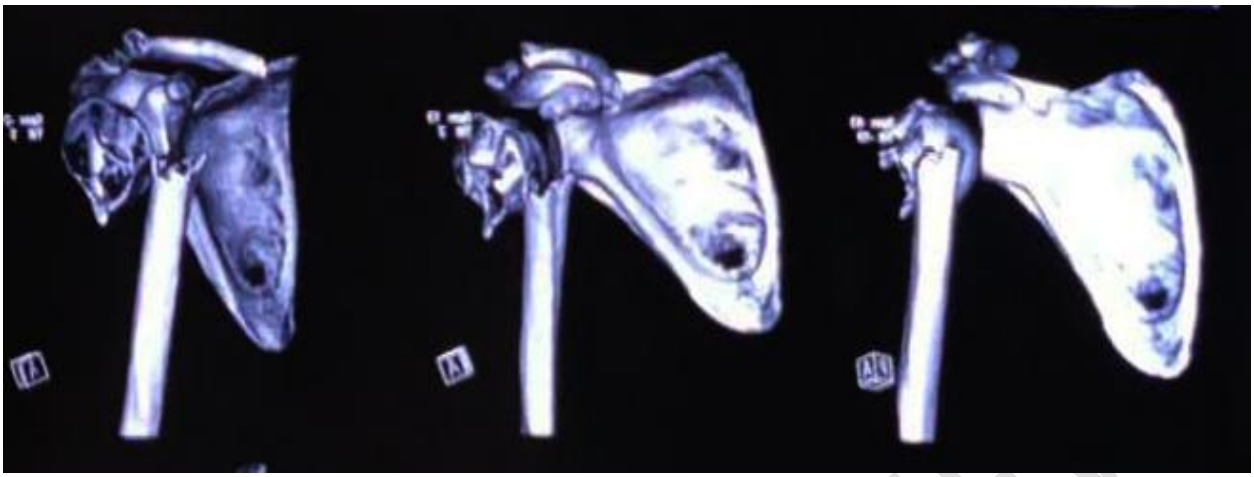
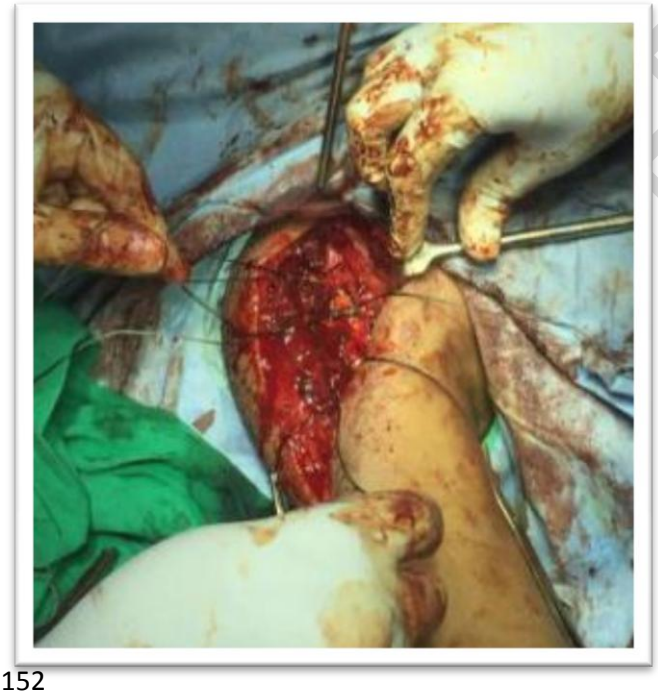


Fig. 04: Pre-operative 3-D reconstruction CT scan of a proximal humerus fracture

Operative procedure

All patients were operated in beach chair position with the head of the bed elevated approximately 45°. The freely draped arm can be extended/hyperextended at the patient's side which help proximal humerus for canal reaming, cementation, and implantation of prosthesis. The standard Deltopectoral approach was used (Fig. 05). Significant adhesions and hematoma were encountered which were removed from the subdeltoid space. The fracture line between the tuberosities is almost always located just posterior to the groove. The first part of the procedure is getting control of the tuberosity fragments. In cases of arthroplasty for three-part fractures, 1st osteotomize the lesser tuberosity from the humeral head, in essence creating a four-part fracture. The humeral head is removed, after which the tuberosities are tagged with heavy sutures (Fig. 06). Three sutures are placed at the bone–tendon interface of the greater tuberosity, and one or two are placed in the lesser tuberosity fragment. Next, the humeral canal is exposed and prepared with sequential reaming. Preoperative films and implant measurements can also be used to assess component to ensure proper height of implant. A trial prosthesis is used to check for correct size and placement of the prosthesis. If the trial prosthesis is loose, bone cement is used to fix stem into the humoral medullary cavity. All prostheses were inserted in 20–30° of retroversion by external rotating and adducting the

arm. The height of the prosthetic stem was determined by the metaphyseal calcar. In case of severe comminution, pectoralis major insertion was taken as a reference point. Anatomically, prosthetic humeral head lies approximately 5.6 cm proximal to the superior border of the pectoralis major tendon.[15] Fixations of the tuberosities around the prosthesis were done by making drill holes and were tied to the prosthesis and proximal humerus using Ethibond No. 5 sutures. Ethibond sutures were passed through the holes over fin and neck of the prosthesis to tightly secure the tuberosities with their soft tissue attachments (Fig. 07, 08). Postoperatively, shoulder immobilizer with sling was given to all the patients. Fig 05: Incision site marking



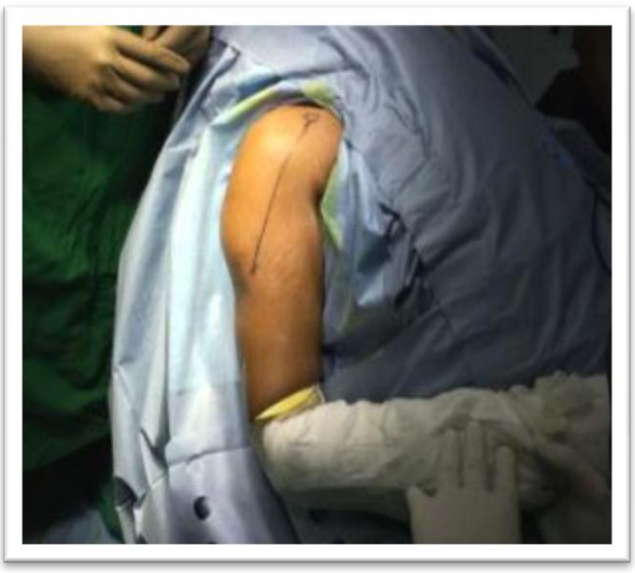


Fig. 06: Tagging of tuberosities

Fig. 07: Fixation of tuberosities with prosthesis

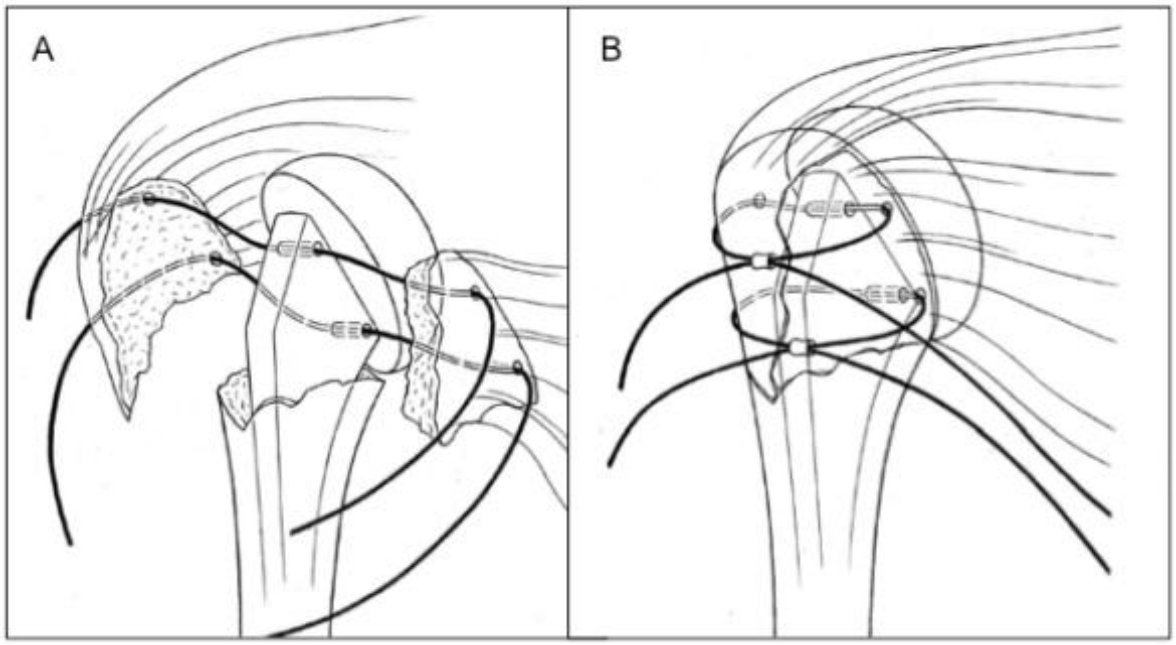


Fig. 08: Schematic diagram of fixation of tuberosities with the prosthesis

CASE 1:

Fig. 09: Post-operative radiograph

Fig. 10: 1 year follow up radiograph

CASE 2:

Fig. 11: Post-operative radiograph

Fig. 12: 1 year follow up radiograph

Post-operative protocol

Immediately after procedure patient is given shoulder pouch with immobilizer which is to be worn for the 1st 2 weeks continuous day and nights and simultaneously patient is started on a rehabilitation program containing active range of motion of the elbow, wrist and hand and passive range of motion of shoulder. External rotation is limited based on intraoperative assessment of repair of tuberosities. Internal rotation is allowed till chest/abdomen and no active external rotation or extension is allowed for the 1st 4 weeks. At the end of 2 weeks post suture removal patient can remove the immobilizer while sleeping at nights. Post-operatively, at 4 weeks immobilizer is removed and passive range of motion and assisted active range of motion are encouraged. By end of 6 weeks light resisted External rotation, forward flexion, abduction and active internal rotation started along with pendulum exercises. Furthermore, radiographs should be taken at 6 weeks to assess tuberosity healing. When evidence of healing is found at approximately 6 to 8 weeks then active assistive with a pulley and isometric strengthening exercises for rotator cuff and deltoid are initiated. These strengthening exercises are continued for next 6 weeks. Daily activities such as personal hygiene and eating are allowed which helps to build early muscle strength and endurance. Patient is encouraged to perform exercises on a daily basis for at least 6 months preferably a year. Weight lifting activities are gradually allowed after 6 months.

Results

All patients were operated at Krishna institute of Medical Sciences, Karad. Mean follow up was 14.3 months (range 11-18 months). Mean age was 61.20 years (range 48–78 years). TEN patients were male and FIVE were female. Mean Constant score was 55.25 (range 43.2-64.4) points at final follow up. Anterior elevation of more than 150° was present in 1 patient and from 90° to 150° in 12 patients. Less than 90° of anterior elevation was present in 2 patients. Mean anterior elevation was 119.5°(range 75^0-150^0). Functional range of abduction for shoulder was 60–120°. Thirteen patients in our study had a functional range of abduction. One patient had <60° and one patient had 130° of active abduction. Mean active abduction was 104° (range 57° - 130°). Mean external rotation was

24° (range 16° - 30°). Internal rotation was not satisfactory in two patients according to Constant scoring system. Proximal migration of tuberosity was present in Two patients. These patients had decreased abduction. No pain to mild pain was present in 13 patients. Two patients had moderate pain at their final follow-up. Twelve (i.e., 80%) patients were satisfied about their functional outcome. Tuberosity migration in two patients and higher placement of prosthetic stem in one patient were the causes of discomfort in three patients. Clinically, this patient had mild pain on elevation above horizontal level. There were no intraoperative complications. No cases of neurological injury, infection, and instability were noted. Heterotrophic calcification was not found in any case. The revision was not done in any case.

Fig. 13: Range of Movements at 1year follow up.

Discussion

The purpose of the study was to evaluate functional outcome after primary hemiarthroplasty in proximal humerus fracture. Primary hemiarthroplasty in displaced three and four part proximal humerus fracture was initially proposed by Neer[(9)] and found to have good results as compared to conservative management in all age group and better than osteosynthesis in elderly. In younger patients, with complex, grossly comminuted, or displaced fractures, primary

hemiarthroplasty can be considered as a primary treatment. Initial varus alignment >20° is also consider a viable indication of primary hemiarthroplasty because of high failure rate in osteosynthesis.[16] Results of primary hemiarthroplasty are better than secondary hemiarthroplasty in cases of posttraumatic malunion, nonunion, and avascular necrosis of proximal humerus.[17-19] We used Constant score for functional evaluation which is universally accepted and validated.[11] The major aims of hemiarthroplasty in fracture of proximal humerus are pain relief, early and adequate shoulder function, patient satisfaction, and strength. Advanced surgical techniques and anatomical tuberosity fixation correlate directly with the outcome. Factors that affect the tuberosity union are positioning of prosthesis, stable fixation of tuberosity, and bone quality (rate of nonunion are higher in elderly and in osteoporotic bone).[16] Higher placement of prosthesis is associated with higher risk of tuberosity nonunion and pain.[16] Hence, the assessment of stem height at the time of implantation is important. During surgery, in neutral position, there should be a gap of at least 1 cm or one finger width between the implant and the acromion.

Boileau et al.[20] showed that tuberosity healing was a major determinant of functional outcome. In their study, 23% patients had detachment and migration of tuberosity, while in our study that was only 13.34%. Modern prosthesis has holes over proximal end of the prosthesis for better attachment and integration of tuberosities. Anatomical healing of tuberosity gives good functional outcome due to the restoration of rotator cuff anatomy. Tuberosity migration was the main complication in our study and produced inferior results in two patients (13.34%).

Castricini et al.[21] performed primary shoulder hemiarthroplasty in 57 patients. Mean Constant score was 59.2 at mean followup of 52 months in their study which reflects good function. In our study, mean Constant score was 55.25 after mean followup of 14.3 months. Although Constant score remains low in primary hemiarthroplasty, it is acceptable in low demanding elderly patients. Major advantage of hemiarthroplasty is pain relief which is the main factor for patient satisfaction. Castricini et al. mentioned very satisfactory results in 91% patient in spite of low Constant score.

Kontakis et al.[22] had done a large systemic review of literature with primary shoulder hemiarthroplasty for proximal humerus fracture. They reviewed 16 similar studies with 810 shoulder hemiarthroplasty done for three or four part proximal humerus fracture and fracture dislocations. The mean active anterior elevation was 105.7° (10–180°) and mean abduction was 92.4° (15–170°). In their study, the main complication was associated with tuberosity healing which occurred in 11.15% cases. Heterotrophic ossification was found in 8.8% cases, and proximal migration of humerus head was in 6.8% cases. The mean Constant score was 56.63 (11–98).

In our study, no patient had severe pain. Two patients had moderate pain at their final followup, while 13 patients had zero to mild pain. Severe pain in hemiarthroplasty was related to the stiffness of shoulder. Early passive movement of shoulder was started in all patients, so stiffness did not develop in any patient. Our study showed that older age and comminution of fracture had significantly affected tuberosity healing.

Liu et al.[23] looked at 33 patients undergoing hemiarthroplasty for fracture and found that healing of the tuberosities was poor in 18 patients; those patients with abnormal tuberosity healing had significantly higher pain scores and lower functional outcomes .

The pain free adequate range of motion of shoulder is the primary goal in shoulder hemiarthroplasty. Tuberosity healing plays the main role in good range of motion and is an important determinant of functional outcome. Our study had no control group, shorter mean followup of 14.3 months and small sample size (n = 15) were limitations of this study. Further study with large sample size and longer followups are required to access the factors related to wear rate and implant loosening.

Conclusion

The study showed that hemiarthroplasty in a grossly comminuted proximal humerus fracture is a viable alternative to osteosynthesis in middle age group and definative mangment in elderly. Tuberosity healing plays main role in good range

of motion and better functional outcome after shoulder hemiarthroplasty.

References

1. Green A, Norris T. Part II: Proximal humeral fractures and fracture dislocations. In: Browner BD, Jupiter JB, Levine AM, Trafton PG, editors. Skeletal Trauma: Basic Science, Management, and Reconstruction. 2nd ed. Philadelphia, PA: Saunders; 2002

2. Court-Brown CM, Garg A, Mc-Queen MM. The epidemiology of proximalhumeralfractures.Acta OrthopScand.2001;72(4):365–71.

3. Harrison AK, Gruson KI, Zmistowski B, et al. Intermediate outcomes following percutaneous fixation of proximal humeral fractures. J Bone Joint Surg Am. 2012;94(13):1223–8.

4. Lanting B, MacDermid J, Drosdowech D, Faber KJ. Proximal humeral fractures: A systematic review of treatment modalities. J Shoulder Elbow Surg 2008;17:42-54.

5. Phipatanakul WP, Norris TR. Indications for prosthetic replacement in proximal humeral fractures. Instr Course Lect 2005;54:357-62.

6. Mighell MA, Kolm GP, Collinge CA, Frankle MA. Outcomes of hemiarthroplasty for fractures of the proximal humerus. J Shoulder Elbow Surg 2003;12:569-77.

7. Bosch U, Skutek M, Fremerey RW, Tscherne H. Outcome after primary and secondary hemiarthroplasty in elderly patients with fractures of the proximal humerus. J Shoulder Elbow Surg 1998;7:479-84.

8. Gerber C, Warner JJ. Alternatives to hemiarthroplasty for complex proximal humeral fractures. In: Warner JJ, Iannotti JP, Gerber C, editors. Complex and Revisions Problems in Shoulder Surgery. Philadelphia: Lippincott-Raven Publishers; 1997. p. 215-43.

9. Neer CS 2nd. Displaced proximal humeral fractures. II. Treatment of three-part and four-part displacement. J Bone Joint Surg Am 1970;52:1090-103.

10. Walch G, Boileau P. Prosthetic adaptability: A new concept for shoulder arthroplasty. J Shoulder Elbow Surg 1999;8:443-51.

11. Wirth MA, Ondrla J, Southworth C, Kaar K, Anderson BC, Rockwood CA 3rd. Replicating proximal humeral articular geometry with a third-generation implant: A radiographic study in cadaveric shoulders. J Shoulder Elbow Surg 2007;16 3 Suppl: S111-6.

12. Neer II CS. Displaced proximal humeral fractures: I. Classification and evaluation. J Bone Joint Surg Am. 1970;52(6):1077–89.

13. Gumina S, Giannicola G, Albino P, et al. Comparison between two classifications of humeral head fractures: Neer and AO-ASIF. Acta Orthop Belg. 2011;77(6):751–7.
14. Constant CR, Gerber C, Emery RJ, Søjbjerg JO, Gohlke F, Boileau P. A review of the Constant score: Modifications and guidelines for its use. J Shoulder Elbow Surg 2008;17:355-61.
15. Murachovsky J, Ikemoto RY, Nascimento LG, Fujiki EN, Milani C, Warner JJ. Pectoralis major tendon reference (PMT): A new method for accurate restoration of humeral length with hemiarthroplasty for fracture. J Shoulder Elbow Surg 2006;15:675-8.
16. Cadet ER, Ahmad CS. Hemiarthroplasty for three- and fourpart proximal humerus fractures. J Am Acad Orthop Surg 2012;20:17-27.
17. Taller S, Krivohlávek M, Lukás R, Srám J, Král M. Hemiarthroplasty for management of proximal humeral fractures. Acta Chir Orthop Traumatol Cech 2007;74:262-7.
18. Fallatah S, Dervin GF, Brunet JA, Conway AF, Hrushowy H. Functional outcome after proximal humeral fractures treated with hemiarthroplasty. Can J Surg 2008;51:361-5.
19. Besch L, Daniels-Wredenhagen M, Mueller M, Varoga D, Hilgert RE, Seekamp A. Hemiarthroplasty of the shoulder after four-part fracture of the humeral head: A long term analysis of 34 cases. J Trauma 2009;66:211-4.
20. Boileau P, Krishnan SG, Tinsi L, Walch G, Coste JS, Molé D. Tuberosity malposition and migration: Reasons for poor outcomes after hemiarthroplasty for displaced fractures of the proximal humerus. J Shoulder Elbow Surg 2002;11:401-12.
21. Castricini R, De Benedetto M, Pirani P, Panfoli N, Pace N. Shoulder hemiarthroplasty for fractures of the proximal humerus. Musculoskelet Surg 2011;95 Suppl 1:S49-54.
22. Kontakis G, Koutras C, Tosounidis T, Giannoudis P. Early management of proximal humeral fractures with hemiarthroplasty: A systematic review. J Bone Joint Surg Br 2008;90:1407-13.
23. Liu J, Li SH, Cai ZD, et al. Outcomes, and factors affecting outcomes, following shoulderhemiarthroplasty for proximal humeral fracture repair. J Orthop Sci. 2011;16(5):565–72.