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# Fractures of the proximal humerus: Does age precludes operative treatment?

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Received: 1 March 2023; Accepted: 10 May 2023; Published: 14 May 2023.

**Abstract: Background:** Fractures of the proximal humerus are extremely common, and these are true osteoporotic fractures. Due to rich vascularity and broad cancellous surfaces most of these fractures can be effectively treated nonoperatively as this imparts a high propensity for healing. In addition, many of these fracture patterns result in adequate bone contact and minimal displacement with acceptable alignment. For displaced fractures open reduction and internal fixation can improve outcomes, depending on the pre-injury functional status of the patient. Unique operative treatment challenges include obtaining and maintaining reduction of small bone fragments with strong muscle forces especially in osteoporotic bone. Many options are feasible, including plates, nails, sutures, and other novel devices. Now locking plates are being used more commonly and for a successful result technical details are critical and this minimizes loss of reduction, the risk of implant failure, and reoperation. To our knowledge, very few studies were done on the outcome of operative treatment of these osteoporotic fractures.

**Material and Methods:** During this observational study, we analyzed all operatively treated proximal humerus fractures between January 2015 and December 2020. Patient selection was on clinical grounds, based on physical, mental, and social criteria. To investigate functional outcome, pain, and ADL limitations we used the DASH Questionnaire. Documented complications were also evaluated.

**Results:** There were total of 128 patients with displaced proximal humerus fractures treated surgically: 30 two-part, 64 three-part, and 34 four-part fractures. Mean DASH scores were 37.5, 36.9, and 48.6, respectively. Overall good results were obtained with the modern locking plates (mean DASH 34.4). In highly comminuted fractures prosthetic treatment were used and this resulted in poorer function (mean DASH 72.9). Again in this sub group persistent pain and ADL limitations were more present (64 and 50% in patients with 4-part fractures vs. 14% in 2-part fractures). Fracture-related and non-fracture-related complication rates were low (non-union 3%; 2 myocardial infarction) and there were no postoperative deaths within 3 months of surgery.

**Conclusion:** It is justifiable to consider surgical treatment in selected comminuted dislocated proximal humerus fractures in patients aged 75 and older.

**Keywords:** Proximal humerus fracture; Locking plates; Complications; Operative treatment; Outcome; Old age.

## 1. Introduction

**P**roximal humerus fractures are most commonly seen in the elderly population, following a trivial injury after hip and wrist fractures [1,2]. The incidence of these fractures is estimated to be around 9 per 1,000 population/year. Majority of these fractures (Up to 80%) are minimally displaced and can be effectively treated conservatively, with the use of a sling and physical therapy with the anticipation that the fracture will heal and the patient will regain function in that joint [3]. Poor functional outcome of conservative management is to be anticipated in moderate to severe displacement and in these surgical interventions is warranted. But the optimal treatment for these patients has not been fully elucidated. Due to the improvements in the design, technology and surgical techniques more and more of these fractures are getting operated surgically. Faster

mobilization, less pain, and better functional outcome are the possible advantages, particularly in younger individuals [4].

To our knowledge, there are no studies related to the outcome of surgically treated geriatric proximal humerus fractures. Insight into the functional outcome in this group is very important especially in view of the fact these patients are now living longer and leading more active lifestyles. Their outcome expectations have changed, and using chronologic age to categorize these fractures is becoming less relevant in this ever increasing number of elderly patients. The treatment goals should be to maximize the function of the shoulder and to minimize the chance of treatment failure, all while working within the expectations of the patient.

Challenges in treating this sub group operatively are the higher risks for surgery, presence of osteoporosis and the difficulties in rehabilitation. Knowledge of the functional outcome in these geriatric patients may help in making the best choice of treatment in terms of quality of life and health care costs and giving them a chance to maintain an independent lifestyle. In addition to functional outcome our study gives more insight into other outcome measures like postoperative mortality, pain and limitation of activities of daily living (ADL).

## 2. Material and methods

This is a multi-centric retrospective observational study. We consulted our institutional review board and because of the retrospective nature of the study no formal ethics approval was required. This research conforms to the Declaration of Helsinki as revised in 2008.

All operatively treated fractures from the age of 75 years and above between January 2015 and December 2020 were included. Operative treatments were selected to those having comminution and after careful physical, mental and psychological evaluation by the treating surgeons. Those patients who presented late and poly trauma patients were excluded. A total of 128 patients were included, with an average age of 80.1 years (SD 3.8) at the time of injury. Of these, 26 patients were lost to follow up: 20 patients had died and 6 cases lacked contact information. Mean follow-up time was 3.7 years (SD 1.4).

Patient characteristics comprised age, gender, side affected, follow-up period, age at time of injury, risk of surgery as reflected by ASA-classification [5], and operative technique. Classification of fractures was according to Neer which is primarily based on the number of main fracture fragments [6]. Of the various surgical techniques open reduction and internal fixation (ORIF) using a locking compression plate (PHILOS), ORIF using K-wires and a tension band construction, or hemi-arthroplasty were used. The choice of a specific treatment were based on several factors: first, patient-related factors, such as more advanced age and frailty, were more often a reason to use a less invasive operative technique such as ORIF using K-wires and a tension band construction; second, surgeon-related factors, such as experience and education in one specific operative technique and third, as the study progressed, the use of a locking compression plate became more popular.

Postoperative rehabilitation included protected active and passive circumduction exercises during the first 4 weeks under the supervision of a physiotherapist. Later progressive active mobilizations were initiated after an x-ray which showed stable and unchanged plate fixation.

Patients records were searched for any documentation on fracture-related complications such as nerve damage, wound infection, and non-union and mortality and were recorded. Also, relevant non-fracture-related complications, such as sepsis, cerebrovascular accidents or thromboembolic disease were looked into.

DASH Questionnaire was used (disability of arm, shoulder, and hand) to investigate functional outcome in 102 patients. Patients with severe psychiatric impairment at follow-up could not be investigated by this questionnaire for this physical impairment and were excluded (n = 16). To evaluate pain and ADL limitations as outcome measures a selection of questions related to pain and ADL limitations were used.

## 3. Results

A total of 128 elderly patients aged 75 years and above were operated during this 5 year period. Table 1 lists the patient characteristics. There were 30 patients with a two-part, 64 patients with a three-part, and 34 patients with a four part displaced fracture of the proximal humerus. By the time of this study twenty patients were deceased, with a mean of 22 months after diagnosis (SD 18 months).

LCP was used in 48 patients (14 two-part, 32 three-part, 2 four-part), tension band construction technique in 30 patients (4 two-part, 20 three-part, 8 four-part) and hemi-arthroplasty in 32 patients (8 three-part, 24

four part). 16 patients required reoperation due to secondary dislocation in this study group. Other surgical techniques for internal fixation were used for 18 patients: intramedullary nail (n = 8), single lag screws (n = 6) and non-LCP (n = 4). Table 3 shows the exact distribution of the patients among the groups.

There were no postoperative deaths within 3 months of surgery in this very old patient cohort. Two patients shows features of myocardial infarction postoperatively. Six patients were treated for urinary tract infection successfully. Two patients each in this group had wound infection and axillary nerve damage. None of the patients had features of osteonecrosis of the humeral head in the follow up period. In four patients non-union occurred and this was in the sub group who got operated with ORIF using LCP (3%). 16 out of the 30 patients initially treated with K-wires and a tension band wire developed secondary dislocation that required reoperation but neither mortality nor additional morbidity was observed. 86 patients were available for analysis of functional outcome. The mean DASH score in patients with a two-part fracture was 37.5 (n = 14) and in patients with a three-part fracture was 36.9 (n = 44). Worse outcome was those suffered a four-part fracture with a mean DASH score of 48.6 (n = 28). Same is with moderate to severe pain and limitations in ADL (Table 2).

Analysis of these according to the operative methods showed a mean DASH scores in ORIF using either a LCP device (n = 34) or a tension band wire technique (n = 18), in spite of necessary re-operations, were 34.4 and 33.9, respectively (Tables 1-3). Those patients treated by hemiarthroplasty fared less well with their mean DASH score being considerably higher at 72.9 (n = 28). In patients treated with LCP moderate to severe pain and ADL limitations were less present (12 and 18%, respectively).

**Table 1.** Patient demographics

|                                 | All  | % or (SD) | Functionalfollow-up | % or (SD) |
|---------------------------------|------|-----------|---------------------|-----------|
| Patients                        | 128  | 100       | 102                 | 67        |
| Age, mean                       | 80.1 | (3.8)     | 81.8                | (4.3)     |
| Gender: female                  | 116  | 91        | 96                  | 94        |
| Affected side: right            | 52   | 41        | 30                  | 38        |
| Psychiatric/physical impairment | 16   | 12        | 16                  | 16        |
| ASA score, mean                 | 2.4  | (0.8)     | 2.3                 | (0.8)     |
| Deceased                        | 20   | 6.4       | -                   | -         |
| Days after surgery              | 670  | (547)     | -                   | -         |

**Table 2.** DASH, pain, and ADL limitation according to fracture classification and surgical technique

| Fracture classification | Number of patients | Mean DASH (SD) | Moderate/severe pain (%) | Moderate/severe ADL limitations (%) |
|-------------------------|--------------------|----------------|--------------------------|-------------------------------------|
| 2-part                  | 14                 | 37.5 (25)      | 1 (14)                   | 1 (14)                              |
| 3-part                  | 44                 | 36.9 (22)      | 7 (32)                   | 9 (41)                              |
| 4-part                  | 28                 | 48.6 (23)      | 9 (64)                   | 7 (50)                              |
| Surgical technique      |                    |                |                          |                                     |
| LCP                     | 34                 | 34.4 (19)      | 2 (12)                   | 3 (18)                              |
| K-wire / Tension band   | 18                 | 33.9 (21)      | 5 (56)                   | 5 (56)                              |
| Hemi- arthroplasty      | 28                 | 72.9 (17)      | 8 (57)                   | 7 (50)                              |

**Table 3.** Detailed report of the cohort

| Neer   | n included | n follow up | Repair              | n included      | n follow-up    | Mean DASH | Moderate/severe pain | ADL limitations |
|--------|------------|-------------|---------------------|-----------------|----------------|-----------|----------------------|-----------------|
| 2-part | 30         | 14          | LCP                 | 14              | 6              | 31.4      | 0                    | 0               |
|        |            |             | K-wire/tension band | 4(1x re op)     | 2(1x re op)    | 36.7      | 0                    | 0               |
|        |            |             | Hemi-arthroplasty   | 0               | -              | -         | -                    | -               |
|        |            |             | Nail                | 6               | 4              | 65.4      | 1                    | 1               |
|        |            |             | Lag screws          | 4               | 2              | 13.3      | 0                    | 0               |
|        |            |             | Non LCP             | 2               | 0              | -         | -                    | -               |
| 3-part | 64         | 44          | LCP                 | 32              | 26             | 36.4      | 2                    | 3               |
|        |            |             | K-wire/tension band | 20 (14 x re op) | 12 (6 x re op) | 39.7      | 3                    | 4               |
|        |            |             | Hemi-arthroplasty   | 8               | 4              | 22.9      | 1                    | 1               |
|        |            |             | Nail                | 2               | 0              | -         | -                    | -               |
|        |            |             | Lag screws          | 2               | 0              | -         | -                    | -               |
|        |            |             | Non LCP             | 2               | 2              | 56.6      | 1                    | 1               |
| 4-part | 34         | 28          | LCP                 | 2               | 2              | 0         | 0                    | 0               |
|        |            |             | K-wire/tension band | 8(0 x reop)     | 6              | 20        | 2                    | 1               |
|        |            |             | Hemi-arthroplasty   | 24              | 20             | 60.1      | 7                    | 6               |
|        |            |             | Nail                | 0               | -              | -         | -                    | -               |
|        |            |             | Lag screws          | 0               | -              | -         | -                    | -               |
|        |            |             | Non LCP             | 0               | -              | -         | -                    | -               |

#### 4. Discussion

Operative treatment of displaced proximal humerus fractures may have a better outcome compared to conservative treatment as per our current literature search, but convincing evidence is not available. This is especially true in older patients since considerable pain and functional limitations remain after both treatment modalities [3,4,8–10].

The aim of this study is look at the functional outcome of those operatively treated proximal humerus fractures in the elderly. It is our belief that due to the improvements in the design, technology and surgical techniques the functional outcomes of these fractures are better. But this has to outweigh the increased risk that these sub groups have especially the higher risks for surgery, presence of osteoporosis and the difficulties in rehabilitation. Even if the results after surgery were excellent and far better than conservative treatment, an elevated risk of mortality and morbidity would raise considerable questions about a justified indication.

Many patients in our study had pulmonary and /or cardiovascular comorbidities, as might be expected in this elderly population. It was only after careful selection on clinical grounds that these older people were subjected for surgery. Patients considered not fit for surgery were treated conservatively with the use of a sling. During our study period, no patient died within 3 months of the operation or re-operation. This suggests that it is safe to perform this surgery in well-selected elderly patients.

Locking plate fixation of humeral fractures had a higher rate of screw cutout and revision surgery especially in patients older than 60 years as per Owsley observations [10]. But in our study, the number of fracture and non-fracture related complications were very low which again points favorably towards surgery in very selected patients.

Functional prognosis becomes worse as the number of fracture fragments increases whether treated conservatively or operatively [5]. This was true in our cohort of elderly patients too. The functional results of operative repair of the 2- and 3-part fractures were satisfactory to good as compared to four-part fractures, often treated with a hemiarthroplasty. The same is with mean DASH scores 37.5 and 36.9 respectively for 2- and 3-part fractures and 53.9 for four-part fractures (Table 2). Patients treated by locked compression plates had adequate pain reduction and functional recovery as compared to all others. Although the tension band group seemed to do well; it should be kept in mind that half of these patients were re-operated. An extra operation in this group of patients is not desirable considering the risks involved. Pain experience, ADL limitations, and the overall functional outcome, as measured by the DASH score, is significantly worse after hemiarthroplasty compared to internal fixation as per our study. This is consistent with Handoll et al. [4]. Hemi-arthroplasty is generally reserved for severely displaced and/or highly comminuted fractures of the proximal humerus. Our rationale for prosthetic repair was for those highly comminuted and dislocated fractures with a high chance for avascular necrosis of the humeral head. Again prosthetic repair was primarily intended for minimizing pain rather than regaining function. However, our study showed that severe pain often persisted even after hemiarthroplasty.

Our study showed that it is safe and justifiable to perform surgical repair using LCP for severely comminuted and dislocated proximal humerus fractures especially in selected patients of 75 years and

older. This might potentially contribute to the preservation of an independent lifestyle by diminishing pain and ADL limitations. But further research is needed to identify specific groups of patients or fracture types that are less suitable for surgical treatment.

**Author Contributions:** All authors contributed equally to the writing of this paper. All authors read and approved the final manuscript.

**Conflicts of Interest:** The authors declare that they do not have any conflict of interests.

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