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Original Article

The Radiographic and Clinical Outcomes of Proximal Humerus Fractures in Patients Over 60 Years of Age

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ABSTRACT

Objective: The objective is to present and compare the results of surgical methods used in the treatment of osteoporotic proximal humerus fractures.

Methods: A retrospective review of patients who underwent surgery for osteoporotic proximal humerus fracture between 2009 and 2013 was conducted. The demographic data of the patients, surgical methodology, concomitant injuries, time intervals before surgery, hospitalization time, and follow-up time were recorded. Constant-Murley Score and ASES (American Shoulder and Elbow Surgeons) Score were utilized for functional evaluation. Shoulder abduction and flexion ranges of motion were measured as objective evaluation.

Results: Sixteen patients (64%) were operated with plate-screw osteosynthesis, 2 patients (8%) with percutaneous k-wire fixation, and 7 patients (28%) with partial shoulder arthroplasty. A significant correlation was identified between treatment and Neer classification ($P = .011$). No significant correlation was observed between functional scores and surgical method ($P > .05$ for each). Objective evaluations revealed a significant difference in shoulder abduction range of motion between patients and surgical method ($P = .030$). Post-hoc analyses showed a significant difference between plate-screw osteosynthesis and hemi-arthroplasty groups ($P = .010$).

Conclusion: Percutaneous techniques, plate-screw osteosynthesis, or arthroplasty methods may be preferred in osteoporotic proximal humerus fractures, with no superiority over each other. The decision regarding the surgical method for geriatric proximal humerus fractures should be based on patient and fracture related factors.

Keywords: Osteoporosis, geriatric proximal humerus fracture, Neer classification, surgery

INTRODUCTION

Proximal humerus fractures can occur even in low-energy trauma, such as simple falls, due to declining bone quality (osteoporosis), especially in older age. Proximal humerus fractures are the most common fracture site after hip and distal radius fractures in the elderly.[1,2] Most geriatric proximal humerus fractures are treated conservatively, given the decreased functional expectation and increased comorbidities. However, for fractures with significant displacement and multiple comminutions, surgical treatment comes to the fore. As a result of the increasing incidence of fractures in this region and technological developments in orthopedic implants, various surgical methods have been used to treat proximal humerus fractures. Despite the numerous studies conducted on the subject, a consensus on the optimal surgical method remains elusive, and the relative merits of each method continue to be debated.[3]

The primary goal of surgery for geriatric proximal humerus fractures is to allow patients to resume their daily activities as soon as possible. The patient's age, bone quality, fracture pattern, and timing of surgery have a critical impact on the patient's functional outcome. Each proximal humerus fracture is patient-specific, and there is no single universal surgical method that can be used for every patient when conservative treatment is not possible. Therefore, a patient-specific, evidence-based treatment approach should be selected.[4]

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This study aims to present and compare the results of surgical methods used to treat osteoporotic proximal humerus fractures.

MATERIALS AND METHODS

Study Population and Data Collection

Following approval by the Gülhane Military Medical Academy Haydarpaşa Training Hospital Ethics Committee (Approval No: 2013-114 Date: 26.12.2013), all patients who underwent surgery for a proximal humerus fracture at the study clinic between October 2009 and December 2013, aged over 60 years were retrospectively reviewed. Verbal consent was obtained from all patients and their relatives. Within the specified period, 38 patients were identified who underwent surgery with a diagnosis of osteoporotic proximal humerus fracture. Inclusion criteria were defined as being over 60, having undergone surgical treatment for a proximal humerus fracture in our clinic, and having regular follow-up visits. Seven patients were excluded from the study because they died for various reasons. Three patients could not be contacted because they changed their contact details. Three patients did not want to take part in the study. As a result, 13 patients could not be included in the study, and 25 patients were included.

Surgical Technique and Rehabilitation

The percutaneous method was used for K-wire fixation.[5] For plate osteosynthesis (Proximal Humerus Locking Plates, TST Orthopedics®, TST Medical Tools®, İstanbul, Türkiye) and arthroplasty (Partial Shoulder Prosthesis, Hipokrat Incorporated Company, İzmir, Türkiye), the proximal humerus was reached through a deltopectoral approach.[6] Passive shoulder exercises were started on the first postoperative day. Patients who did not have any problems at the wound site were discharged and asked to have dressings every day. All patients were contacted for a follow-up 2 weeks after the operation, at which point sutures were removed. In the third postoperative week, active assisted shoulder exercises were introduced in addition to passive shoulder exercises. Postoperative rehabilitation recommendations were obtained for all patients, and home rehabilitation plans were arranged and encouraged.

MAIN POINTS

- Different surgical alternatives are not superior to each other in terms of functional scores in geriatric proximal humerus fractures.
- Satisfactory clinical results can be obtained with plate-screw osteosynthesis in geriatric proximal humerus fractures.
- Patient-based and fracture-based factors should be considered when deciding on the surgical method in geriatric proximal humerus fractures.

Demographic Data and Functional Evaluation

Anteroposterior (AP) and lateral radiographs or computed tomography (CT) scans of the shoulder taken on admission were used to classify proximal humerus fractures according to the Neer classification.[2] Computed tomography scans were used to diagnose and classify cases of multiple comminuted fractures and fracture dislocations and to determine the surgical method. None of the patients underwent magnetic resonance imaging. Concomitant injuries and the procedures performed for these injuries were recorded. Waiting times for surgery after fracture, reasons, and comorbidities were recorded. The methods used for surgery (K-wire fixation, plate and screw fixation, and arthroplasty) were listed.

Patients were contacted using the contact details in the hospitalization file and the hospital information system. Included patients were invited to our hospital by telephone, provided that a minimum follow-up of at least 1 year had been achieved. Constant-Murley scoring and ASES (American Shoulder and Elbow Surgeons) scoring were used for functional assessment.[7,8] Constant-Murley scoring was used for clinician-based assessment and ASES scoring was used for patient-based assessment. Radiological assessment was performed with direct AP and lateral radiographs of the shoulder. Fixation failure and union were assessed on direct radiographs. In terms of objective evaluation, shoulder abduction and flexion ranges of motion were measured on all patients at the last follow-up. Using a standard universal goniometer and the triangulation sites, the same physician assessed the patient's range of motion.

Statistical Analysis

The International Business Machines (IBM®) Statistical Package for the Social Sciences (SPSS®) software, version 26.0 (IBM SPSS Corp.; Armonk, NY, USA), was used to conduct the statistical analysis. Mean, SD, and minimum-maximum values were used as descriptive statistics. Frequency (percentage) was used as descriptive statistics for categorical data. When evaluating the scale data in 3-group comparisons, the groups were compared using the Kruskal-Wallis Test, and post-hoc analyses were carried out using the Mann–Whitney U-test. The categorical data were compared using the chi-square test. When the *P*-value was less than .05, statistical significance was deemed to exist.

RESULTS

Sixteen patients (64%) were operated with plate-screw osteosynthesis, 2 patients (8%) with percutaneous k-wire fixation, and 7 patients (28%) with partial shoulder arthroplasty. The mean age of the patients was 75.08 ±

8.505 years (range: 60-92). According to Neer classification, 10 patients (40%) had 2-part fractures, 13 patients (52%) had 3-part fractures, and 2 patients (8%) had 4-part fractures (Figure 1). Detailed demographic data of the patients are shown in Table 1.

It was determined that 62.5% of the patients treated with plate-screw osteosynthesis had Neer Type 2 fractures and 85.7% of the patients treated with arthroplasty had Neer Type 3 fractures. There was a significant correlation between the treatment and Neer classification (P = .011). There was no significant correlation between the treatment and other fracture and patient characteristics (Table 2).

There was no significant correlation between the functional scores and the surgical method applied in the last follow-up of the patients (P > .05 for each). In the objective evaluations, there was a significant difference between the shoulder abduction range of motion of the patients and the surgical method applied (P = .030). Post-hoc analyses revealed no significant difference between osteosynthesis with plate-screw and fixation with k-wire (P = .941) and between fixation with k-wire and hemi-arthroplasty (P = .111), whereas a significant difference was found between osteosynthesis with plate-screw and hemi-arthroplasty groups (P = .010). The relationship between the applied surgical method and functional and objective measurements is shown in detail in Table 3.

In 1 patient treated with plate osteosynthesis, revision plate osteosynthesis was performed in the sixth postoperative week due to loss of reduction. In the follow-up of the same patient, parenteral antibiotherapy was applied for superficial infection due to serous discharge at the wound site and the complaint regressed. In another patient treated with plate osteosynthesis, the fixation materials were removed 1.5 years postoperatively due to pain and abduction limitation despite physiotherapy, and the complaints disappeared afterward.

DISCUSSION

Surgical techniques for proximal humerus fractures include many options such as minimally invasive techniques, plate and screw applications, hemiarthroplasty, and total shoulder arthroplasty. Our study investigated the superiority of 3 different surgical techniques described in the literature for osteoporotic proximal humerus fractures. The most important finding of our study was that none of the surgical methods investigated was superior to the others in terms of functional scores. Another point that should be emphasized is that the shoulder abduction range was greater in the plate-screw osteosynthesis group.

Table 1. Demographic Profile of the Patients

		Number of Patients (%) (N = 25)
Gender	**Female**	23 (92%)
	Male	2 (8%)
Age* (years)		75.08 ± 8.505 (60-92)
Side	**Right**	10 (40%)
	Left	15 (60%)
Mechanism of injury	**Simple fall**	23 (92%)
	Traffic accident	2 (8%)
Neer classification	**Type 2**	10 (40%)
	Type 3	13 (52%)
	Type 4	2 (8%)
Time interval between injury and initial hospital admission* (days)		14.12 ± 30.783 (0-151)
Time interval between initial hospital admission and operation* (days)		18.48 ± (3-153)
Postoperative hospitalization* (days)		14.6 ± 12.049 (3-66)
Surgery	**Plate-screw osteosynthesis**	16 (64%)
	Kirschner wire fixation	2 (8%)
	Arthroplasty	7 (28%)
Follow-up* (months)		32.36 ± 15.545 (12-54)

*Mean, SD, and minimum-maximum values were used as descriptive statistics.
N, number of patients.

Table 2. Comparison of Demographic Characteristics of Patients According to Surgical Groups

		Plate-Screw Osteosynthesis (n = 16)	Kirschner Wire Fixation (n = 2)	Arthroplasty (n = 7)	*P*
Gender	**Female**	15 (93.8%)	2 (100%)	6 (85.7%)	.594
	Male	1 (6.2%)	0	1 (14.3%)	
Age* (years)		74.06 ± 8.903 (60-92)	73 ± 9.899 (66-80)	78 ± 7.789 (67-87)	.427
Side	**Right**	7 (43.7%)	1 (50%)	2 (28.6%)	.827
	Left	9 (56.3%)	1 (50%)	5 (71.4%)	
Mechanism of injury	**Simple fall**	15 (93.7%)	2 (100%)	6 (85.7%)	.594
	Traffic accident	1 (6.3%)	0	1 (14.3%)	
Neer classification	**Type 2**	10 (62.5%)	0	0	***.011***
	Type 3	5 (31.3%)	2 (100%)	6 (85.7%)	
	Type 4	1 (6.3%)	0	1 (14.3%)	
Time interval between injury and initial hospital admission* (days)		15.06 ± 37.049 (0-151)	12.5 ± 17.678 (0-25)	12.43 ± 17.329 (0-47)	.897
Time interval between initial hospital admission and operation* (days)		18.88 ± 36.527 (4-153)	17.50 ± 16.236 (6-29)	17.86 ± 17.883 (3-53)	.529
Postoperative hospitalization* (days)		12.06 ± 5.961 (3-23)	7.5 ± 3.536 (5-10)	22.43 ± 19.603 (10-66)	.091

*Mean, SD, and minimum-maximum values were used as descriptive statistics.
N, number of patients; P, statistical significance value.

In epidemiological studies, osteoporotic proximal humerus fractures are more common in women, and fractures usually occur in low-energy trauma, such as falls from the same level. In our study, proximal humerus fractures were more common in women (92% vs. 8%). Our results are consistent with the literature. In epidemiological studies with larger patient series, fractures are more common in women, and the incidence of fractures increases with the aging of the population.[9]

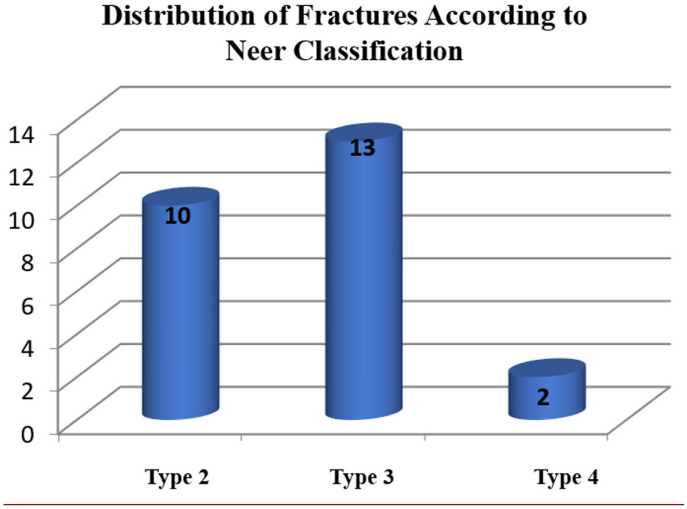

Figure 1. Distribution of fractures according to Neer classification.

In our study, the mean interval between initial presentation and surgery was calculated to be 18.48 (3-153) days. The large discrepancy between the waiting times was due to several patients were initially being indicated for conservative management, while surgery was later decided upon due to loss of reduction. One patient underwent surgery at a late stage due to non-union. The mean length of hospital stay in our study was 14.6 (3-66) days. Prolonged preoperative preparation and increased need for postoperative care due to comorbidities and concomitant fractures were the reasons for the increased length of hospital stay. Eighteen patients had comorbidities. These included hypertension, diabetes mellitus, heart disease, hyperlipidemia, lung disease, Alzheimer's disease, hypothyroidism, and chronic renal failure. In addition, 6 patients in our cohort had concomitant fractures: - The first patient had a lateral plateau fracture and osteosynthesis was achieved with 2 cannulated screws. Additionally, a symphysis pubis arm fracture and a fibular shaft fracture were conservatively managed. - The second patient had a concomitant patella fracture that was fixed with a traction device. - The third patient underwent intramedullary nailing for the diaphyseal fracture of the femur. - The fourth patient's distal radius fracture was treated with closed reduction and a short arm cast. - The fifth patient had partial hip arthroplasty performed for a collum femoris fracture. - The sixth patient underwent proximal femoral nailing for an intertrochanteric femoral

Table 3. Functional Scores and Range of Motion of the Patients

	Plate-Screw Osteosynthesis (n = 16)	Kirschner Wire Fixation (n = 2)	Arthroplasty (n = 7)	*P*
ASES Score	64 (35-95)	82.5 (75-90)	53 (18-88)	.165
Constant Murley Score	76 (31-95)	82.5 (77-88)	42 (17-90)	.050
Shoulder flexion Range of motion	100 (50-155)	127.5 (125-130)	55 (25-170)	.053
Shoulder flexion Range of motion	90 (40-145)	95 (80-110)	65 (20-110)	***.030***

Mean, SD, and minimum-maximum values were used as descriptive statistics.
ASES, American Shoulder and Elbow Surgeon; N, number of patients; P, statistical significance value.

fracture and closed reduction with percutaneous pinning for a distal radius fracture.

In our study, 10 patients (40%) had Neer Type 2 fractures, and 13 patients (52%) had Neer Type 3 fractures. Although osteoporotic fractures are expected to be more comminuted due to the fragile bone structure, our results differ from this hypothesis. We believe that the most important reason for this is that almost all the injury mechanisms in our study (92%) were caused by low-energy injuries. Another important reason for the low number of multisegment Neer Type 4 fractures in our cohort may be that conservative treatment of these fractures, especially in the geriatric population, is more prominent both in the literature and in our study group.[10,11]

Although higher functional scores were obtained with K-wire fixation and plate-screw osteosynthesis compared to the arthroplasty group, the difference between them was not statistically significant in our study. Similar results have been reported in the literature. However, recent studies have reported that reverse shoulder arthroplasty is preferred to partial shoulder arthroplasty in geriatric multisegment proximal humerus fractures, and the functional results are similar to those of plate osteosynthesis.[12,13]

The most striking finding of our study was the significant difference in shoulder abduction range of motion at the last follow-up ($P = .03$). In post-hoc analyses, no significant difference was found between plate-screw osteosynthesis and K-wire fixation ($P = .941$) and between K-wire fixation and hemiarthroplasty ($P = .111$), whereas a significant difference was found between the plate-screw osteosynthesis and hemiarthroplasty groups ($P = .010$). When analyzing the reasons for this situation, it is striking that the groups were not homogeneously distributed. The limited number of patients with percutaneous fixation (K-wire) may have influenced the statistical analyses. Another point to emphasize is that the rate of Neer Type 2 fractures was higher in the plate-screw fixation group. Finally, all arthroplasties in our study were partial shoulder arthroplasties. As mentioned above, the number of publications in the literature reporting satisfactory results with reverse shoulder arthroplasty for proximal humeral fractures is increasing daily.[13,14]

Our study had some limitations. These are

1. The number of patients and surgical techniques used in our study was small, and the groups were not homogeneous,
2. The absence of reverse shoulder prosthesis cases among the surgical methods used, which are becoming more common today,
3. Differences in the time interval between hospital admission and surgery,
4. Postoperative bone mineral density (BMD) was not measured, and the relationship between BMD age and BMD fracture incidence was not evaluated.

In conclusion, the number of osteoporotic fractures is increasing with the aging of the population, and proximal humerus fractures constitute a significant proportion of these. There are many surgical methods for treating geriatric proximal humerus fractures, and our study showed that these surgical methods are not clearly superior to each other. Although arthroplasty options have become increasingly prevalent in this age group due to technological advancements, satisfactory clinical outcomes can be achieved with plate-screw osteosynthesis in geriatric proximal humerus fractures.

Availability of Data and Materials: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethical committee approval for the study was received from Gülhane Military Medical Academy Haydarpaşa Training Hospital Ethics Committee (Approval No: 2013-114 Date: 26.12.2013).

Informed Consent: Verbal consent was obtained from all patients and their relatives.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – S.S.O., K.K.; Design – S.S.O., K.K.; Supervision – K.K.; Resources – S.S.O., K.K.; Materials – K.K.; Data Collection and/or Processing – S.S.O., K.K.; Analysis and/or Interpretation – S.S.O, K.K.; Literature Search – S.S.O.; Writing Manuscript – S.S.O.; Critical Review – K.K.; Other – S.S.O., K.K.

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