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Is arthroplasty necessary for three and four-part proximal humerus fractures in elderly?

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Ethics Committee Approval
Ethics approval for this study was obtained from Lokman Hekim University Ethics Committee with the decision no:2021/068(code no:2021066) and approval was given on 15/06/2021.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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Abstract

Background/Aim: Proximal humerus fractures are common in elderly patients. Treatment of three and four-part fractures is especially controversial in these patients. In recent years, surgical options have been widely used, especially among shoulder surgeons. The purpose of this study was to compare clinical results of conservative and arthroplasty methods.

Methods: Between 2016 and 2020, 30 patients who were treated for Neer type 3 and type 4 proximal humeral fractures were included in the study. Patient data were evaluated retrospectively and then divided into three groups. Group 1 was treated conservatively, group 2 underwent hemiarthroplasty; and group 3 underwent reverse total shoulder arthroplasty. CONSTANT and visual analog scale (VAS) scores and radiological results at six months were evaluated retrospectively from patient records. At the last control they have been evaluated with CONSTANT, University of California/Los Angeles. (UCLA), and VAS scores.

Results: Twenty-three (76.7%) of the patients included in the study were females. The mean age was 73.5 (5.7) years. The mean follow-up period was 33 (2.5) months. The mean follow-up periods in groups 1–3 were 33.3 (2.9), 32.8 (2), and 32.2 (2.9) months, respectively. When the CONSTANT scores of the patients were compared at the sixth month, they were observed to be better in the reverse total shoulder arthroplasty group (P = 0.001). Final control CONSTANT scores in the hemiarthroplasty group were lower than in the other groups (P = 0.001) and similar in the reverse shoulder prosthesis and conservative treatment group (P = 1). When the UCLA scores of all groups were compared, the mean UCLA scores were found to be significantly higher in groups 1 and 3 compared to group 2 (P = 0.001). When the VAS scores of the patients were compared, a significant difference between all groups was detected (P < 0.05). The highest VAS scores were observed in group 2, the second highest in group 1, and the lowest in group 3.

Conclusion: For treatment of proximal humerus fractures in the elderly, patients should be evaluated according to activity levels and expectations, and surgical treatment should be suggested rather than ordered.

Keywords: Humerus fractures, Elderly patients, Revers shoulder arthroplasty

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Introduction

Proximal humeral fractures account for 60% of fractures in adults, and 75% of the proximal humeral fractures are observed in individuals over 60 years of age. These fracture are the third most common osteoporotic fractures after hip and wrist fractures [1–3]. After the age of 60, the incidence is higher in women than in men [3]. The presence of additional diseases, such as diabetes mellitus, neuromuscular weakness, and dementia, leads to an increase in the the risk of occurrence. Such fractures are an important cause of morbidity in elderly patients, and treatment of these fractures is regarded as time-consuming and expensive [4, 5].

Eighty-five percent of proximal humeral fractures are usually non-displaced or slightly displaced fractures and are treated conservatively. However, in comminuted fractures, a classification method should be used for treatment selection of these fractures. The most widely used method for classifying proximal humeral fractures is the Neer classification system. This classification is based on the number of pieces and amount of displacement when defining a fracture. Four anatomical segments of proximal humerus are evaluated primarily. These segments are humeral head, greater tuberosity, lesser tuberosity, and humeral shaft [6]. A separation of more than 1 cm between fragments and an angulation of more than 45 degrees with the humeral shaft is defined as a four-part fracture and constitutes 3% of all proximal humeral fractures [7].

Although most fractures are treated conservatively, the choice of treatment is more complex and still unclear for four-part fracture. Surgical options include percutaneous fixation, open reduction and internal fixation, and arthroplasty. While surgical treatment options show good clinical results in young patients, they may show variable results and higher complication rates in elderly patients [8]. Poor bone quality in elderly patients leads to difficulties in internal fixation and causes complications, such as loss of reduction and avascular necrosis [9, 10]. Studies showing that internal fixation is not superior to conservative treatment are have been published [11].

Also, another treatment modality, arthroplasty, is available when open reduction and internal fixation can not be used. In studies comparing open reduction and internal fixation with arthroplasty, open reduction and internal fixation yields lower results in terms of quality of life and clinical scores. This difference leads to more frequent revision surgery after complications such as nonunion, screw penetration, and implant failure [9, 10]. Arthroplasty is applied using two different treatment methods: (1) hemiarthroplasty and (2) reverse total shoulder prosthesis.

Considering the studies conducted in recent years, the surgical option is increasingly preferred in the treatment of proximal humeral fractures [12, 13]. In our study, we aimed to investigate the clinical and radiological results of the patients to whom three different treatment options were applied for proximal humeral fractures.

Materials and methods

Ethics committee approval was obtained for our study from the non-interventional ethics committee of Lokman Hekim University Faculty of Medicine on June 15, 2021 with document number 2021/068, and all patients gave written informed consent for the use of their data in the study. Thirty patients who were treated for proximal humeral fractures between 2016 and 2020 and whose full records could be accessed were included in the study. Patients were treated in two different centers. Inclusion criteria were determined as having a three and four-part proximal humerus fracture according to the Neer classification system, being over 65 years old, being able to read, write, and cooperate. Exclusion criteria were defined as having ipsilateral upper extremity pathology, multitrauma, age less than 65 years old, and/or history of open reduction-internal fixation, revision surgery, and/or pathological fracture.

Patient data were accessed through the hospital automation system. Age, gender, American Society of Anesthesiology (ASA) score at the time of surgery, dominant extremity, mechanism of fracture, joint range-of-motion (ROM) level in controls, and clinical scores were evaluated over the records. They were divided into three groups according to the treatment methods. Group 1 was treated conservatively, Group 2 w patients who underwent hemiarthroplasty, and group 3 were determined as patients who underwent reverse total shoulder arthroplasty. CONSTANT and Visual Analogue Scale (VAS) scores and radiological results at six months were evaluated retrospectively from the records of the patients. Each patient was called for the final follow-up and evaluated with CONSTANT, University of California at Los Angeles (UCLA), and VAS scores.

Conservative treatment protocol

It was observed that the patients in group 1 were treated conservatively because of the risk in surgery due to additional medical problems or because the patient did not accept surgical treatment voluntarily. After the first evaluation of all patients in the conservative treatment group, closed reduction and shoulder arm slings were applied, and control evaluation was performed radiographically. The patients were evaluated with control radiographs once a week for the first three weeks and then at the sixth and twelfth weeks. After the second week, passive joint range-of-motion (ROM) exercises were started, and at the sixth week, the shoulder arm sling was removed and active ROM exercises were started. After the sixth week, the patients were directed to the physical therapy unit, and they were gradually oriented in terms of carrying loads and using them in daily activities at the twelfth week.

Arthroplasty treatment protocol

According to the preference of the surgeon, hemiarthroplasty (Biomet, USA) or reverse total shoulder arthroplasty (Zimmer-Biomet, USA) was applied to patients in Groups 2 and 3, depending on factors, such as the presence of an intact rotator cuff, absence of arthrosis in the glenoid, and the desire to keep the operation time short. The deltopectoral approach was used as a surgical opening in all patients. The humeral stem applied to the patients in both groups was cemented. The patients stayed at the hospital for an average of one night after the surgery and were given an arm sling for one

week after which passive joint ROM exercises were started. After three weeks, the arm slings were removed, and patients were directed to the physical therapy unit.

Clinical evaluation

When the records of the patients were evaluated, the CONSTANT (14) score and ROM data were available at six months. Evaluation results were determined as bad for > 30 points, poor for 21 to 30 points, good for 11 to 20 points, and excellent for < 10 points. After assessing the records, patients were called for their final controls. CONSTANT scores were applied, results were compared with those of the patients' intact shoulders, and the differences recorded. Also, at the final control, UCLA (15) and VAS scores were also evaluated for the patients. UCLA shoulder scores were evaluated as bad–poor in case of < 27 points and good–excellent for > 27 points. The results were compared between each group.

Radiological evaluation

All patients were evaluated with shoulder anterior–posterior (AP) radiography and shoulder computerized tomography (CT) at the first admission. The conservatively followed patients were checked with shoulder AP radiography at the first, second, third, and sixth week and again at three and six months and were evaluated with shoulder AP radiography at their last follow-up. Patients who underwent arthroplasty were checked with AP shoulder radiography on the first post-operative day, sixth week, and at three and six months (Figure 1), and were evaluated with AP shoulder radiography again at the last follow-up. In the evaluation of arthroplasty patients, a radiolucent area of more than 2 mm around the humeral stem on direct radiography was considered a loosening sign.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) 22 package program. Data were expressed as mean and standard deviation (SD). The homogeneity of the data was evaluated with the Levene test. The analysis of quantitative variables between groups was performed using an analysis of variance (ANOVA) test. The results were evaluated at the 95% confidence interval (CI), and the significance was evaluated at the $P < 0.05$ level. A post-hoc Benferroni test was performed in groups with significant results based on the ANOVA test.

Results

The patients included in the study were mostly female. Three males and eight females were in Group 1, two males and seven females in Group 2, and two males and eights females in Group 3. The mean age of all patients was 73.5 (5.7) years. The mean age of the patients was 76.4 (4.2) in Group 1, 75.8 (6.7) in Group 2, and 68.3 (1.2) in Group 3. The mean follow-up period of all patients was 33 (2.5) months. The mean follow-up periods in Groups 1–3 3 were 33.3 (2.9), 32.8 (2), and 32.2 (2.9) months, respectively. When the fracture formation mechanisms of the patients were evaluated, 60% were due to simple falls (n = 18), 23% in-vehicle traffic accidents (n = 7), 10% falls from height (n = 3), and 7% were due to motorcycle injuries (n = 2). The injured extremity was the dominant one in 66% of the patients (n = 20). According to the evaluation of the patients at the time of injury, 6% were determined as ASA 3 and 63.3% as ASA 4. When the fracture type, gender, follow-up period, and dominant extremity status of the patients were compared, no statistically significant difference was found ($P > 0.05$) as shown in Table 1.

Table 1: Distribution of patients according to gender, American Society of Anesthesiologists (ASA) scores, mechanism of fracture formation, and fracture type

		Group 1 (n = 11)	Group 2 (n = 9)	Group 3 (n = 10)
Gender	Male	3(27.3%)	2(22.2%)	2(20%)
	Female	8(72.7%)	7(77.8%)	8(80%)
Dominant extremity	Right	6(54.5%)	6(66.7%)	8(80%)
	Left	5(45.5%)	3(33.3%)	2(20%)
ASA	ASA 3	0(0%)	4(44.4%)	7(70%)
	ASA 4	11(100%)	5(55.6%)	3(30%)
Mechanism of formation	Simple fall	7(63.6%)	7(77.8%)	4(40%)
	Traffic accident	2(18.2%)	1(11.1%)	4(40%)
	Falling from high	1(9.1%)	1(11.1%)	1(10%)
	Motorcycle accident	1(9.1%)	0(0%)	1(10%)
Fracture Type	Neer 3	6(54.5%)	6(66.7%)	7(70%)
	Neer 4	5(45.5%)	3(33.3%)	3(30%)

* Patient numbers are given along with their percentage in groups in parenthesis.

At six months, the mean CONSTANT score of all patients was 11 (3.9). In Group 1, Group 2 and Group 3, these scores were 16.9 (1.7), 14.4 (2.9), and 7.5 (1.3), respectively. When the CONSTANT scores of the patients were compared, no significant difference between scores at six months between groups 1 and 2 were found ($P = 0.272$). Significant differences between Groups 2 and 3 and Groups 1 and 3 were noted. ($P = 0.001$). CONSTANT scores at six months were observed to be better in the reverse total shoulder arthroplasty group. The CONSTANT scores of the patients at the last control were 10.1 (2.7), 29.6 (6.4), and 10.3 (3.1) in Groups 1–3, respectively. When the CONSTANT scores of the groups at the last control were compared, significant differences between Groups 1 and 2 and between Groups 2 and 3 were found ($P = 0.001$). No significant difference between Groups 1 and 3 was found ($P = 1$). Final control CONSTANT scores in the hemiarthroplasty group were low compared to the other groups and similar in the reverse shoulder prosthesis and conservative treatment groups (Tables 2, 3).

Table 2: UCLA, CONSTANT, VAS, 6thmonth mean CONSTANT scores and range of motion of the patients

	Group 1	Group 2	Group 3	*P*-value
UCLA	28.6 (2.4)	16.7 (2.8)	30.6 (2.9)	0.001
CONSTANT	30.6 (2.9)	29.6 (6.4)	10.3 (3.1)	0.001
VAS	5.0 (1.2)	8.6 (0.8)	2.0 (1.0)	0.001
CONSTANT 6th month	16.0 (1.7)	14.4 (2.9)	7.5 (1.3)	0.001
Flexion	128.6 (7.1)	94.4 (9.8)	165.0 (6.2)	0.001
Abduction	121.8 (6.8)	86.6 (5.0)	165.5 (6.4)	0.001
Extension	24.5 (4.7)	16.6 (5.0)	33.5 (2.4)	0.001
Total	(n = 30)			

Analysis of variance (ANOVA) test, UCLA: University of California at Los Angeles; VAS: visual analog scale

Table 3: Comparison of UCLA, CONSTANT, VAS and joint range-of-motion (ROM) of the groups (post hoc Bonferroni test)

Compared Groups			*P*-value
UCLA	Group 1	Group 2	0.001
		Group 3	0.337
	Group 2	Group 3	0.001
CONSTANT	Group 1	Group 2	0.001
		Group 3	1.000
	Group 2	Group 3	0.001
VAS	Group 1	Group 2	0.001
		Group 3	0.001
	Group 2	Group 3	0.001
CONSTANT 6th month	Group 1	Group 2	0.272
		Group 3	0.001
	Group 2	Group 3	0.001
Flexion	Group 1	Group 2	0.001
		Group 3	0.001
	Group 2	Group 3	0.001
Abduction	Group 1	Group 2	0.001
		Group 3	0.001
	Group 2	Group 3	0.001
Extension	Group 1	Group 2	0.001
		Group 3	0.001
	Group 2	Group 3	0.001

The mean UCLA score of all patients was 25.7 (6.5). In Groups 1–3, 3, these scores were 28.2 (2.4), 16.7 (2.8), and 30.6 (2.95), respectively. When the UCLA scores of all groups were compared, statistically significant differences were found between Groups 1 and 2 and Groups 2 and 3 ($P = 0.001$), but no statistically significant difference was found between Groups 1 and 3 ($P = 0.337$). The mean UCLA scores were found to be significantly higher in Groups 1 and 3 compared to Group 2 (Tables 2, 3).

When the VAS scores of the patients were compared, significant differences between all groups were found ($P < 0.05$). The highest VAS scores were observed in group 2, the second highest in group 1, and the lowest in group 3 (Tables 2, 3).

While the mean flexion, abduction, and extension scores were 128 (7.1), 121 (6.8), and 24.5 (4.7) in group 1, they were 94.4 (9.4), 86.6 (5), and 16.6 (5) in group 2 and 165 (6), 165 (6.4) and 33.5 (2.4) in group 3, respectively. When the groups were compared in terms of joint ROM, statistically significant differences between all groups ($P = 0.001$) were found (Table 2, 3).

Superficial infection developed in two patients in groups 2 and 3. These patients have recovered with oral antibiotic therapy. The fractures of all patients in group 1 were healed. No patient was lost during the follow-up.

When the radiographs of the patients in groups 2 and 3 were examined at the last follow-up, loosening was detected in one patient in group 2. Surgery was recommended, but the patient refused. No loosening was detected in any patient in group 3.

Discussion

Proximal humeral fractures are seen as the most common fracture type after hip and wrist fractures, especially in elderly patients with osteoporosis. In the United States alone, more than 1.5 million osteoporotic fractures are reported annually, of which more than 400,000 are proximal humeral and pelvic fractures [16]. Proximal humeral fractures are more commonly defined according to the Neer classification system, and when evaluated according to this classification, most of the fractures are minimally displaced or displaced as 1-2-piece fractures. These fractures are mostly treated conservatively. No definitive scientific evidence regarding which treatment is the most appropriate treatment choice for complex fractures. Considering that proximal humeral fractures are more common in elderly osteoporotic patients, treatment costs and risk of morbidity constitute a social problem. Studies in the literature demonstrating different results have been published [8, 9, 17–19].

The development of implant technology used in surgery and the increase in the applicability of surgical techniques have brought the surgical option to the forefront in the treatment of proximal humeral three and four-part fractures [12, 13]. The results of open reduction and internal fixation are good and widely used in the treatment of patients with proximal humeral fractures who are less than 65 years of age. With the advances in locking plate technology, use of this technology in osteoporotic proximal humerus fractures has increased; however, the complications and revision surgery rates also seem to be high [20]. In a review published in 2012, it was reported that re-operation rates were unexpectedly high in complex proximal humerus fractures in which locking plate fixation treatments were applied [21].

In our daily practice, we apply locking plates to young patients in accordance with the literature. If our patients over 65 years of age will undergo surgery, arthroplasty is preferred over other options. The patient groups included in our study consisted of patients who underwent conservative treatment due to high ASA scores or patient rejection after the decision in favor of surgery or underwent arthroplasty after humeral fracture. For the patients who underwent arthroplasty, hemiarthroplasty and reverse total shoulder arthroplasty implantation decision was made as a result of intra-operative evaluations. It was observed that hemiarthroplasty was performed during the operation when the patient's rotator cuff was intact, no degenerative lesions on the glenoid were found, and a shorter operation time was desired. Also, reverse shoulder arthroplasty was performed in cases in which the rotator cuff was not intact, a degeneration existed on the glenoid, and tubercles were fragmented.

When the studies with hemiarthroplasty applications in proximal humerus fractures were evaluated, a study published in 2003 in which hemiarthroplasty was performed with the appropriate technique was found to affects shoulder functions positively and lead to a reduction in pain [17]. In the same study, it was determined that improper fixation of the tubercles in the hemiarthroplasty application caused poor clinical results, and the highest complication was nonunion in the greater tubercle. In another study in which comparing internal fixation and hemiarthroplasty applications were compared, patients were evaluated via the CONSTANT, Disabilities of the Arm, Shoulder and Hand (DASH) score, health-related quality of life (HRQoL) and EQ-5D (Euro QolGroup, Rotterdam, The Netherlands) scores [10]. While a significant increase in the HRQoL score in the hemiarthroplasty group was noted, no significant difference was observed in other results. In another review study, it was stated that when hemiarthroplasty applications are performed with the appropriate technique, clinical results are reported to be higher than internal fixation [22]. When the studies examining hemiarthroplasty applications were evaluated; while painless shoulder movements were expected, good clinical results were associated with tuberosity union, and that was observed at a higher rate in young patients with high bone stock in large tubercle [23, 24]. Complications of hemiarthroplasty include infection, wound problems, nerve injuries, intra-operative fractures, instability, nonunion and migration of tuberosities, rotator cuff tears, component malposition and loosening, joint stiffness, and heterotrophic ossification [25]. When the literature is evaluated, it seems difficult to perform successful hemiarthroplasty surgeries in proximal humeral fractures because a successful surgery depends on many factors. In our study, the postoperative results of the hemiarthroplasty group had lower clinical scores when compared with conservative treatment and reverse total shoulder arthroplasty.

When comparing reverse shoulder arthroplasty and hemiarthroplasty applications in complex proximal humerus fractures in the literature; reverse shoulder arthroplasty was found to provide better clinical results, ROM, and fewer

complications [26, 27]. The basic requirement in reverse shoulder prosthesis applications is sufficient deltoid muscle strength. The fact that the anatomical placement and tubercle healing are not needed and the reverse shoulder prosthesis is not affected by the absence of the rotator cuff can be factors leading to better clinical results compared to hemiarthroplasty [27–29]. In our study, clinical results and joint ROM were significantly better in reverse shoulder arthroplasty applications compared to hemiarthroplasty; our results are in line with the literature. We think that the comparison of CONSTANT scores with a healthy shoulder during clinical evaluation in our study creates a different result compared to the general literature, and this finding is valuable in showing joint function on an individual basis. In this way, we believe the age of a patient is not relevant to that clinical regression of the shoulder functions.

In our study, no significant difference between the patients who underwent reverse shoulder arthroplasty and the conservative follow-up in terms of clinical outcomes was found. Our results are also compatible with the literature. In a study conducted by Lopiz et al. [30] in 2019 in which 29 patients with reverse shoulder arthroplasty and 30 patients with proximal humerus fractures who had conservative treatment were compared, they found no significant difference between the two methods based on VAS scores and clinical scores during the 12-month follow-up period. They reported that in the group treated with reverse shoulder arthroplasty, they did not encounter any significant complications other than the suprascapular nerve injury. Complications developed in only two cases, and in these two cases, no problem other than the difficulty of pain control was reported. In the conservatively followed group, all cases resulted in radiological malunion, and osteonecrosis was observed in 58% of them. However, the development of osteonecrosis was not associated with low CONSTANT and DASH scores. In our study, all patients who were treated conservatively recovered in the presence of malunion. However, the presence of malunion did not affect clinical scores. In fact, the joint ROM and clinical scores were significantly higher than those of hemiarthroplasty group. This difference suggests that it may be related to the low expectation in the elderly patient group with a high morbidity rate. Additional surgical trauma in the hemiarthroplasty group may be associated with poor clinical outcomes. The same situation was not encountered in the reverse shoulder arthroplasty group, and this finding may be related to the fact that reverse shoulder arthroplasty applications are independent of tuberosity healing and rotator cuff strength. The patients who underwent surgery who were included in the study did not develop any complications other than superficial infections.

Our study has limitations, including a retrospective nature and a small number of patients. Longer patient follow-ups may yield more meaningful results. However, evaluating the advanced age group shortens the follow-up period. We think that the comparison of the three groups in our study is an advantage in terms of contributing to the literature.

Conclusions

As a result, conservative treatment applications in three and four-part proximal humerus fractures in elderly patients do not yield poor clinical results when compared with arthroplasty applications. Conservative treatment shows even better results than hemiarthroplasty. The most important finding of our study was that the results of conservative treatment and reverse shoulder prosthesis treatment were similarly good, and the clinical results of the patients who underwent hemiarthroplasty were worse than these two groups. This finding shows us that the choice of hemiarthroplasty treatment in three and four-part old proximal humerus fractures produces a poor quality of life for the patients.

In this study, we support the hypothesis that the results of the surgical option are not more effective than the conservative treatment and that surgery should not be rushed in elderly.

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