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Evaluation of the functional and radiological results in the patients who came with proximal humerus fracture for which they underwent osteosynthesis plating with deltopectoral approach

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Abstract
Aim: Evaluation of the functional and radiological results in the patients who came with proximal humerus fracture for which they underwent osteosynthesis plating with deltopectoral approach.
Materials and Methods: Our study included patients who underwent proximal humeral anatomic locking plate with deltopectoral approach due to proximal humeral fracture (PHF) between 2022-2023. Patient who attained skeletal maturity, with closed humeral fractures, isolated unilateral humerus fracture were included in our retrospective study. The functional outcome were compared with the contralateral normal side using the Constant-Marley score and radiological results with the full anteroposterior radiography and collodiaohyseal angles.
Results: The Constant Murley scoring categorical data structure of the patients, the operated side was 6.1% (N=2) poor, 6.1% (N=2) moderate, 39.4% (N=12) good, 48.5% (N=16) excellent. Statistical difference was found between the operated side and the healthy side ($p>0.05$). While the mean Constant Murley score of the operated side was 85.82 ± 7.07, the mean Constant Murley score of the healthy side was 90.67±5.76. While the average of the collodiaphyseal angles of the operated side was 130.03±4.64; the mean of the angles of the intact side was 135.64±5.04.
Conclusion: The Constant Murley scoring categorical data structure of the patients, the operated side was 6.1% (N=2) poor, 6.1% (N=2) moderate, 39.4% (N=12) good, 48.5% (N=16) excellent. Statistical It has been observed that both clinical and functional results of the patients were successful after plate osteosynthesis using the deltopectoral approach and proximal humerus anatomical locking plate in proximal humerus fractures.

Keywords: Proximal humerus fracture, Deltopectoral approach, Plate osteosynthesis

Introduction
Proximal humerus fracture is most common with elderly population. About 5% of all the fractures seen in elderly patient is PHF [3]. The mood of treatment is mostly conservative and can be treated with a sling immobilization and physical therapy. However, approximately 20% of displaced proximal humeral fractures require surgery. Both conservative and surgical mode of management available. The mode of treatment is selected based on the age and type of fracture [6].
The most common used is implant in cases of surgical mode of management for PHF is the Proximal Anatomical Locking Plate (PHALP). The advantage of using this PHALP as an implant are: 1. It has very less soft tissue damage due to its low profile. 2. Repair of rotator cuff muscles at the proximal plate. 3. Can be screwed at different angles [7].
There are various surgical approaches for PHF such as deltopectoral approach, anterolateral acromial approach, limited deltoid splinting approach and percutaneous approach. This study evaluates deltopectoral approaches for Proximal plating.
This study aims to evaluate the functional outcome and results of the patients who underwent PHILOS plating via deltopectoral approach and compared to the contralateral normal shoulder.

Materials and Methods

33 patients who diagnosed with PHF in 1 year (2022-2023) and underwent PROXIMAL HUMERAL ANATOMICAL LOCKING PLATE(PHALP) used as implant with the deltopectoral approach were included in the study.

Around 80% of the PHF are managed conservatively as PHF are mostly undisplaced. These 80% are managed conservatively with initial immobilisation and followed up by rehabilitation. The conservative mode of management is recommended for PHF if the displacement is less than 1 cm and anglulation less than 45 degree. Indication for surgery are tubercle displacement of more than 5mm, Neer 3 or 4 part fragmented fractures, surgical neck neer 2 fragment fractures, fracture dislocation.

Patient over the age of 18 years, with closed humerus fracture and with intact contralateral humerus and shoulder were included in our retrospective study. Our study does not involve patients with pathological fractures, fracture-dislocation, possible neural damage, another other fracture along with PHF. The results were compared with the Constant-Marley score and were measured by measuring the collodiaphyseal angles on the anterioposterior radiograph. The fractures were classified according to AO classification.

The patients were followed up at 2nd week, 4th week, 3rd month, 6, 12th month for the functional outcome with radiological evaluation.

Surgical application

All the patents were taken under general anaesthesia, the patient was positioned in chaise lounge position and landmarks were identified. Deltopectoral approach was used in all the patients. An approximately 10 cm incision was made from the crocodile process towards the deltoid insertion. The cephalic vein was indenified and preserved in the deltopectoral space. A Hohmann retractor was placed just lateral to the acromian under the deltoid muscle. The other Hohmann was placed along the humeral shaft, and the third was placed just distal to the subscapularis tendon on the medial side. Fracture segments were reduced in accordance with anatomical structure and PHALP was placed. Rotator cuff tears were sutured using Ethibond as the suture material and with Kirshner wire holes in the proximal plate. Fracture reeducation and collodiophyseal angle were observed under c-arm fluoroscopy intraoperative. The surgical site was closed. Wound inspection was done on 2nd postoperative day and physiotherapy with ROM exercises were started from 3rd postoperative day. Patients were discharged on 5th postoperative day if no complications. Sutures were removed on post-operative day 14.

Radiological results were evaluated by comparing the colloodiaphyseal angle in the anteroposterior radiography with collodiaphyseal angles. In the collodiaphyseal angle measurement. In the collodiaphyseal angle measurement, the line drawn parallel to the articular surface of the humeral head and the line passing through the middle of the humeral head were drawn perpendicular to each other. The angle between the line passing through the humeral head and the line passing through the midline of the humeral shaft was accepted as the collodiaphyseal angle (Figure 3). The collodiaphyseal angle of the fracture side was corrected intra operatively according to the measured collodiaphyseal angle of the healthy side.

Functional results between the operated and healthy sides were evaluated with the help of Constant-Murley score system.The Constant-Murley score (CMS) is used to monitor limb function after shoulder surgery[10]. It is a 100-point scale. Scoring scale is divided into four parts. Consisting of pain, strength, activities of daily living and range of motion. Higher the scoring in patients better the shoulder functions [11].

Statistical analyzes

The analyzes obtained in our study were examined with the SPSS (Statistical Program in Social Sciences) 25 program. The compatibility of the data with normal distribution was checked with the Kolmogorov Smirnov Test [12]. The significance level (p) for comparison tests was accepted as 0.05. Since the distribution of the variables was normal ($p>0.05$), statistical analysis was performed using parametric test methods. Comparisons in paired groups; The significance test of the difference between the two means (two independent samples t-test) was performed. In the evaluation of categorical data, the chi-square (x2) test was performed by creating cross.

Results

In this study, 2 of the patients were proximal A2, 11 A3, 7 B1, 4 B2, 6 C2, according to the AO/OTA classification. Between January 2022 and January 2023, 33 patients who underwent PHALP with deltopectoral approach for humeral fracture (PHF) were included.

The demographic information of the patients, the mechanism of injury and additional pathologies are shown in Table 1. Two of the patients (6%) had both proximal humeral fractures and fractures extending to the distal shaft. In these two patients, double plate osteocentesis was performed by extending the incision with a distally lateral approach. Rotator cusp rupture was present in 5 patients (15%) and were sutured using plate holes.

The mean age of the patients was 45.7, 13.47, the follow-up period was 7.36‡1.67 months, the intraoperative blood loss was 17.85 ‡3.37 ml, and the time of union was 16.15:2.79 weeks.

It was tested whether there was a correlation between the Constant-Murly scores (excellent, good, moderate, poor) between the operated side and the healthy side in the participants included in the study, and the results are shown in Table 2. According to the Constant-Murly scores of the participants included in the study, there was no statistically significant relationship between the operated side and the healthy side ($p>0.05$, Table 2).

A statistically significant difference was found between the operated side and the healthy side according to the Constant-Murly scores and collodiaphyseal angle values in the participants included in the study ($p<0.05$, Table 3).

In the patient controls, deep infection developed in 1 (3%) patient 3 months later and the plaque was removed. Avascular necrosis (AVN) and nonunion developed in this patient. One (3%) patient union was with minor varus deformity. No valgus deformity was found in the patients. Impingment syndrome was not observed in any patient.

Discussion

80% of patients diagnosed with PHF are treated conservatively and surgical treatment is recommended for only 20%[13]. Although the indication criteria for surgical treatment in PHF may differ, surgery is recommended especially for displaced fractures with more than two comminuted fractures [14]. They stated that open reduction and plate osteosynthesis are the most commonly used surgical treatments [14]. In the study of Vajara *et al.*, 30 patients with PHF were operated with deltopectoral opening. The mean

Constant scores were 84; 47% (14) excellent, 37%[11] good, 13% (moderate, 3% (1) poor. Mean Constant scores were 84; 14 patients excellent, 11 patients good, 4 patients moderate, 1 poor (15). In the study of Khan *et al.*, For functional outcomes, 19(12.41%) patients had poor results, 30(19.60%) had fair results, 37(24.18%) had good results and 67(43.79%) had excellent results [16]. In our study, in the comparison of the categorical (excellent, good, moderate, bad) data structure of the Constant-Murly score, it was determined that the number of excellent and good patients on the healthy side was 32, and the number of excellent and good patients on the operated side was 29 (Table 2).

It was observed that the patients whose condition was determined as moderate and bad in the intact shoulder were 1 person, and the patients whose condition was determined as moderate and bad on the operated side were 4 people. It was determined that the number of patients with satisfaction observed on the operated side was 29. According to the Constant-Murly scores of the patients included in the study, no statistically significant relationship was found between the operated side and the healthy side ($p>0.05$, Table 2). This shows that a functional result close to a healthy shoulder was achieved in our study.

In the study of Kavuri *et al.*, 4.6% avascular necrosis and 1.5% nonunion were detected [17]. In some studies, nonunion after open reduction and internal fixation (ARIF) has been reported in 12% to 34% of proximal humerus three-part fractures and 41-59% of four-part fractures [18-21]. In the study of Peter *et al.*, 4 of 16 patients developed non-union [22]. In our study, AVN (secondary to infection) developed in 1 (3.3%) patient.

In the study of Joon *et al.*, the postoperative neck-shaft angle of patients who underwent plateosteocentesis with the deltopectoral approach was 132.918.7 [23].

Wang *et al.* reported that complications could be reduced, shoulder function could be improved, and better postoperative outcome could be achieved in patients who underwent open reduction and platyosteocentesis with postoperative neck-shaft angle greater than 127° [24]. In our study, the neck-shaft angle averaged 130.03 4.64 degrees. In the study of Vajara *et al.*, a comparison of head shaft angle at immediate post-operatively with final follow up, 73% (22) was in normal range between 125-145 degrees which 1 case had secondary change into minor varus, bone quality and stability of the whole construction. The skin sutures are removed after 2 weeks. Elbow, wrist and hand motion are encouraged initially. Results of Proximal Humeral Fracture Fixation with Anatomical Locking Compression Plate using 6 stepwise Intraoperative Criteria in Surgical Procedures: a Retrospective Study. 17% (5) minor varus initially, 3% (1) minor valgus, 7% (2) major valgus (15). In our study, union in minor varus deformity was observed in 1 (3%) patient. No valgus deformity was found. As a result of our study, it was observed that the shoulder functions were better as the head-neck angle of the fractured extremity approached the head-neck angle of the intact extremity.

Thompson *et al.* reported that the success rate in Deltopectoral open reduction and internal fixation in fractures is high [25]. Rouleau *et al.* compared the deltopectoral and deltoid split approaches in Neer type 2 and 3 fractures in their study (26). It was observed that the deltopectoral approach had better functional results compared to the deltoid split approach in proximal humerus neer 2 and 3 fractures that underwent locked-plate osteocentesis [26]. The data obtained in Rouleau's study were in favor of the deltopectoral approach [26]. In our study, functional results close to a healthy shoulder were obtained in patients who underwent deltopectoral approach.

Limitations

The limitations of our study can be counted as a small number of patients, the absence of a comparative group with other surgical approaches and implants, and the short follow-up period.

Table 1: Demographic and General feature

Variable	Group	No of Patients	Percent
Gender	Male	18	545
	Female	15	15.5
Side	Right	17	51.3
	Left	16	48.5
	Traffic Accident	10	30.3
Injury Mechanisus	Fall	23	69.7
	No additional pathology	28	84.8
	Forum fracture	1	3.0
	Tibia Fracture	1	3.9
Additional Pathology	Foream fracture	1	3.0
	30 fracture	2	6.1

Table 2: Relationship between operated side and intact side according to Constant - Murley score

Intact side			Operated ide	Total	P-Value
Excellent	No	20	10	38	
	Percent	66.7	48.5	57.6	
Variable					
Good	No	10	1.3	23	
	Percent	30.3	39.4	34.8	0.299
Moderate	No	I	2	3	
	Percent	3.0	6.1	4.5	
Coustant Murley Score					
Pour	No	0	2	2	
	Percent	0.0	6.1	3.0	

P: Chi-square(X^2) test-statistic significance value, No: Number of patients

Table 3: Comparison of Operated and healthy sides according to Constant - Murley score

Variable Constant-Murley Score	Group Intact side	Mean+/- SS 90.671/5.76	Test value	P-Value
	Operated side	85.82 / 7-0.7	1.052	0.003*
Collodiaphyseal Angle	Intact side	135.64+/- 5.04		
	Operated side	128.3+/-5.15	5.848	0.001 *

SD: Standard deviation, Test: Significance test value of the difference between the two means, *p 0.05. There is a statistically significant difference between groups

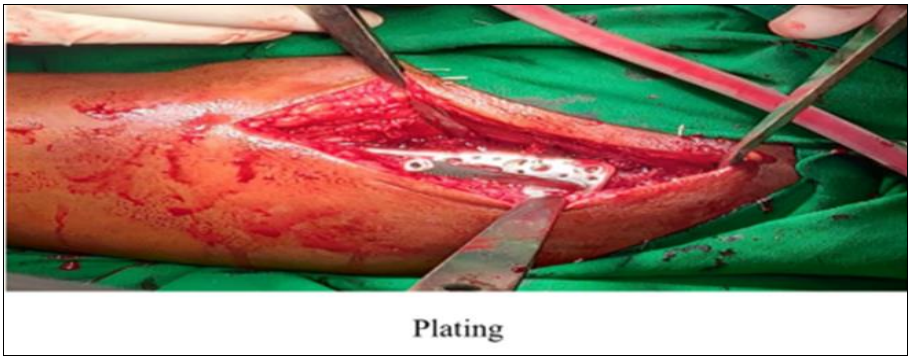

Fig 1: PHILOS Plating

Fig 2: C ARM Images of PHILOS Plating AP

Fig 3: Post-operative x-ray of ORIF with plating of PHF using deltopectoral approach

Conclusion

As a result, it was observed that both clinical and functional results of the patients were successful after plate osteosynthesis performed using the deltopectoral approach and proximal humerus anatomical locking plate in proximal humerus fractures. In addition, thanks to the fact that locking screws can be applied to the proximal humerus locked anatomical plates and there are holes that allow us to suture the rotator cus tears; It provides stability that can allow shoulder movement in the early period and helps patients gain a function close to their healthy shoulder. The deltopectoral approach, on the other hand, allows us to evaluate the anatomy of both the fracture and the rotator cuff, thanks to the wide surgical field it provides for proximal humeral fractures, and facilitates our intervention in proximal humeral fracture extending distally.

Conflict of Interest

Not available

Financial Support

Not available

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