Research Article

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Outcome Analysis of Plate Fixation for Proximal Humerus Fractures

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ABSTRACT

Objective: we aimed toanalyze the functional and radiologic outcomes of proximal humerus fractures internally fixed with an anatomical proximal humerus locking plate.

Methods: forty patients with proximal humerus fractures who were treated with an anatomical locking plate were investigated after a mean follow-up of 24 months. University of California Los Angeles (UCLA) score was used to assess the participants; the method of the American Academy of Orthopedic Surgeons on the operated shoulder and comparative radiographs on both shoulders were applied to assess their range of motion.

Results: it wasshown that 46.5% ofthe results, based on the UCLA score, were good or excellent.We found that that the greater the number of parts in the fracture and the greater the patient's age were, the worse the results were. Elevation and UCLA score were correlated with the anatomical neckshaft angle in antero-posterior view; post operativevarus deviations >15^0 depicted the worst results ($p < 0.001$).

Conclusion: as we found in our study, varus deformity more than 15^0 were not well endured; The variation in the neck-shaft angle measurements in anteroposterior view demonstrated a significant relationship with the range of motion. This factor might be one of the predictors of functional results from proximal humerus fractures fixed by a locking plate.

Introduction

Proximal humeral fractures are common fractures; they account for 5–10% of all fractures [1] with a seventy percent occurrence in patients > 60 years old [2]. They represent the second most common upper limb fracture and the third most common in patients > 75 years old [3]. Surgical treatment is reserved for patients with fractures which are displaced, unstable, open, and associated with vascular injury, or in multiple trauma individual [4] as stated in the literature, there is no unique treatment option used for all types of proximal humeral fractures [5,6]. Internal fixations of the proximal humerus with anatomical plate needs the maintenance of surgical reduction, allocating earlier passive mobilization in consequence facilitating post-operative rehabilitation [7]. Conversely, this technique is not free of complications. The most common complications are: range of motion limitation, varus deformity of the humeral head, humeral head avascular necrosis, device loosening, penetration of articular screws into the articular surface, and [1,8] This study's aim was to assess the outcome of proximal humerus fracture internally fixed by philos plate.

Methods

This was a retrospective study carried out in Akhtar Supreme Orthopedic Center, from September 2018 to February 2019, on 55

patients with proximal humerus fracture who underwent surgery via open reduction and internal fixation with anatomical PHILOS plate. The subsequent cases were excluded from the study: 1 infected case (re-operated for removal of the synthesis material); 1, developing humeral head avascular necrosis; 2 cases due to positive history for frozen shoulder in either side, 2 individuals who used corticosteroid for any reasons, 1 due to rheumatologic disease, 1 case owing to pathologic fracture, 2 patients due to inadequate sessions of post-operative rehabilitation physiotherapy because of lung comorbidity and financial limitations, 3 individuals who were passed out and 2 missed follow ups; hence , 40individualsentered into our analysis: The mean age was 65 year±15 SD; The most common mechanism of injury was falling down from standing height in 90% of cases; 18(45%) had a left-sided fracture on and 22 (55%) were right-sided; 18 (45%)fractured occurred in the dominant side; 23 (57%) were female.

Frequency of age by gender is shown in. The mean follow-up duration was 24 months (range 20–30 months). The classification was used in this study, 18 (45%) were classified as two-part, 10 as three-part (25%), and 12 as four-part (30%). All patients were approached via delto-pectoral incision and followed post op care by the same hospital rehabilitation physiotherapy protocol. Rotator cuff tendons were also repaired if injury noticed while operating. Evaluating the functional outcomes, cases with a minimum of 6 months of follow-up were analyzed. Flexion and rotation degree of both shoulders was calculated according to the American Academy of Orthopedic Surgeons [9] protocol. The University of California in Los Angeles (UCLA) score, [10] which employs subjective and objective criteria and gives scores based on pain, shoulder function, strength, degree of mobility and patient satisfaction was also used; the maximum score would be 35. Radiographies were obtained on the same day by the same qualified personnel at least six months post-operatively. Postoperative radiographic evaluation was standardized; with correction of anteversion of the glenoid cavity and limb in neutral rotation; scapular Y and Velpeau view [11] .

The radiographic taken were the cervicodiaphyseal angle (formed by the intersection between a line perpendicular to the anatomical neck and a line parallel to the axis of the humeral diaphysis), compared to the non-operated shoulder in true AP view [1], and distance between the proximal end of the plate and the greater tuberosity apex on the true AP view of shoulder. For the difference analysis of cervicodiaphyseal angle in AP incidence, a variation up to 15 varus was used as an evaluation index, following the line of thought introduced by Solberg et al. [12,13] For the analysis of the distance between the apex of the greater tuberosity and the plate, participants were divided into two groups: group 1 had values lower than 8mm, and group 2 had values greater than or equal to 8mm; the correlation between changes in radiographic measurements and functional results was investigated. In addition, presence of avascular necrosis, pseudoarthrosis and osteolysis was checked on X-rays. Chi-squared test and Shapiro–Wilk test were applied to analyze associations and the normality of the variables, respectively. Paired and unpaired Student's t-test, ANOVA, and nonparametric Mann–Whitney tests, all with 5% significance level, were used to analyze Continuous variables. Statistically significant results were considered those with *P* values lower than 0.05. The data gathered was analyzed with SPSS 18.0 and STATA 11 SE. All stages of the study were under supervision of local Ethics and scientific Board of the Shahid Beheshti University of Medical Sciences; informed consent was obtained from all participants [14].

Results

Functional outcome of the 40participants were analyzed, mean internal rotation (IR) detected as thumb-T9 (T4-L5) of the operated shoulder versus thumb-T7 (T4-L1) for the contralateral side; the mean elevation for the operated limb was 124^0 ± SD 26.4^0 (range $80–180^0$);as for the contralateral shoulder, a mean of 150^0 ±18^0 (range $115–180^0$) was obtained. The in the UCLA score, [15] 25 (62.5%) patients marked with excellent and good points; 12 (30%), fair; and 3 (7.5%) were poor. Of the total, 35 (87.5%) patients were satisfied and five (12.5%) were unsatisfied with the operation results. 18 patients (45%) had two-part fractures, with a mean UCLA score15 of 32.1. Compared to the contralateral side, the loss in range of motion was: 15.6^0 for elevation ($155.5-139^0$); 5.8^0 for external rotation ($56.9–62.7^0$); and internal rotation remained at T7 in operated and contralateral side; 10cases (30%) had three-part fractures, with an average UCLA score of 28.Amotion loss of 34^0 (20%) of elevation for the operated shoulder was noted comparing with the other shoulder.

The mean external rotation (ER) was 45^0, ±SD 19.2^0 (Range $5-75^0$) for the operated shoulder. In the contralateral shoulder, the mean was 63.1^0±SD14.4^0 (range $30-85^0$). An external rotation loss of 17^0 (30%) was seen for the operated side in comparison with the contralateral shoulder. Compared to the contralateral side, the loss in range of motion was: 35^0 in elevation ($126–161^0$); 22^0 for external rotation ($45.8–5.5^0$); and the average internal rotation moved from thumb-T9 to thumbT7 in the opposite shoulder. The worst scores in the study were obtained in four-part fractures, observed in 12 patients (30%), with mean UCLA score of 25. Compared to the contralateral side, the loss in range of motion was 40^0 for elevation ($107–147^0$); 27^0 for external rotation ($32–59^0$); and the mean internal rotation went from T10 in the operated shoulder to T7 in the contralateral shoulder. Younger patients (60 ≥) had the best out comes as in the UCLA score ($p = 0.003$), external rotation ($p< 0.001$), internal rotation ($p = 0.004$), elevation ($p< 0.001$), and variation of the cervicodiaphyseal angle ($p = 0.008$) in comparison with older participants (> 60 years ;).

Statistically significant outcome was noticed ($p < 0.05$) when correlating the flexion and the UCLA score with the age of the patient and the number of fracture parts based on the Neer classification. As the age and the number of parts increased, the flexion and UCLA score became poorer. Two cases (5%) suffered avascular necrosis and one (2.5%) had infection; It was not feasible to evaluate the pre-established study measurements for these two

patients. the mean cervicodiaphyseal angle in AP view was: 132^0 on the operated side (range: 81–172^0; SD: 14^0) and 139^0 in the contralateral shoulder (range: 123–154^0; SD: 6.8^0). The greatest differences were observed in four-part fractures, specifically in the anteroposterior view, which illustrated a difference of 22^0 in comparison with non-operated side. Patients having less than 15^0 difference in the cervicodiaphyseal angle in anteroposterior view between the operated shoulder and the contralateral side had better functional outcomes: better UCLA score ($p < 0.001$), higher flexion ($p < 0.001$), better external rotation ($p < 0.001$), and better internal rotation ($p = 0.04$;).

Correlation was detected between cervicodiaphyseal angle measurement in anteroposterior incidence and elevation ($p = 0.008$) and UCLA score ($p = 0.004$). When measuring the distance between the proximal end of the plate and the apex of the greater tuberosity, a mean of 6.5mm (range: 0–14mm; SD: 3.4mm) was noted. The comparisons among the results of the UCLA score elevation, external rotation, and cervicodiaphyseal angle between the two groups were not significantly different. The worst functional outcomes were seen in patients where the difference between the operated and contralateral side was greater than or equal to 15^0 varus in the anteroposterior incidence. In such cases, the patients had lower mean flexion (107.6^0) and worse UCLA score (24.3). Patients who had variations lower than 15^0 had mean flexion of 139.1^0 and mean UCLA score of 30. These results were statistically significant in our current study. For analysis of the distance between the proximal end of the plate and the apex of the greater tuberosity, patients were divided into two groups: the first: values lower than 8mm, and the second, values greater than or equal to 8mm. In all participants the proximal end of the plate was placed caudal to the apex of the greater tuberosity. When comparing the flexion, the first group showed mean flexion of 119.5^0 and the second 127.8^0. There were no statistically significant differences between these 2 groups [16].

Discussion

We found that patients would not tolerate more than 15^0 varus deviations in comparison to contralateral side in AP view; result in a worse UCLA score and flexion loss as well. Solberg et al. [17,18] alsoreportedthe same results; although they considered less than 5^0 of humeral head varus angulation as a good reduction and reduction of 5^0 to 20^0 of varus deformity for the humeral head was acceptable in their study. They concluded those with varus deformity greater than 20^0, had flexion loss and worse functional outcome. Ina review article [14], these parameters were also highlighted important. Brunner et al. [15] reported inferior results when the reduction of the fracture had cervicodiaphyseal angle with an increased varus but their findings were not statistically significant. Robinson et al. [16] found that rigorously displaced fractures are more likely to increase varus deformity and suggested osteosynthesis when using locking plates in patients with under100^0 cervicodiaphyseal angle. In our current study, in spite of the distance between the proximal end of the plate and the apex of the greater tuberosity, a small non-significant difference was seen in patients' functional outcome.

Regarding functional evaluation, five patients had poor UCLA score and were not satisfied with the treatment. Two case of avascular necrosis was detected who were also considered as poor based on the UCLA score. One patient had osteonecrosis of the greater tuberosity. In the literature, the osteonecrosis incidence in proximal humerus fracture ranges from 4% to 16% [17]. Patients with avascular necrosis had the worst functional out comes but elderly patients having lower functional demand, endure such complication better [18] in our present study, it was shown 46.5%excellent and good results which are much below levels reported in the literature. A previous report [19] showed 75% excellent and good results in their 4-year follow-up like another published report which showed 75% excellent results [20]. In our present study, as the ageand the number of parts of the fracture increased the UCLA score and the flexion became significantly worse ($p < 0.001$).In a previous study [21] it was noticed that the lack of medial support and more fracture parts were decisive indicesto the functional outcome. Another study [22] besides advanced age associated with worse outcomes. Other limitations include measurement bias and errors; it was much precise if all patients received rehabilitation physiotherapy by the same single staff; the single surgeon conducted the operations; participats were homogenous in terms of compliance and socioeconomically. There is no universal standardized method to measure cervicodiaphyseal angle [23]. Further studies with greater emphasis on such factors are required to establishour findings [24].

Conclusion

As The patients' age and the number of parts of the fracture increases, the functional outcomes will be worse. Cervicodiaphyseal angle which was considerably associated with shoulder range of motion could be a prognostic factor of functional outcomes in the proximal humerus fractures fixed internally with plates.

Conflicts of Interest

The authors declared no conflicts of interest.

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