

Results of surgery using a locking plate for proximal humerus fractures in patients older than 80 years: A retrospective case series

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Abstract

Background: To evaluate the results of surgical treatment using a locking plate for proximal humeral fractures in patients aged >80 years.

Methods: Between September of 2013 and March of 2016, there were 22 patients who received locking plate fixation from proximal humeral fractures over 80 years-old. Among the 22 cases, Clinical, radiological results were analyzed for 19 patients who were able to follow up more than one year. We analyzed bone union, neck-shaft angle, UCLA score, range of motion compared to opposite side and complication. Clinical, radiological results were investigated for medial comminuted fracture or not.

Results: All the patients achieved bone union. The mean bone union time was 13.7 weeks, and the mean neck-shaft angle was 126.4. The mean University of California, Los Angeles, shoulder score was 22.4, and score was <28 point in 12 patients. The mean forward flexion, abduction, external rotation, and internal rotation angles were 129.2°, 112.3°, 44.2°, and L2. All motions were significantly different from the normal shoulder motion. A significant difference was found in the loss of neck-shaft angle according to the medial comminuted fracture.

Conclusion: In the surgical treatment of proximal humeral fractures in patients aged >80 years, use of a locking plate attained bone union with relatively satisfactory results. However, we considered that prevention of and training for postoperative stiffness are necessary. Other surgical methods should be considered for patients with complex displaced fractures, especially those with medial comminuted fractures.

Background

Proximal humeral fracture is the third most common fracture and occurs in approximately 6% of total fractures, with increasing incidence recently [12]. Conservative treatment is performed in older patients with low expectations due to medical problems, and good results can be expected in the absence of displacement or in simple two-part fractures [4, 6]. However, in patients with displaced proximal humeral fractures, surgical treatment should be performed to restore shoulder function with firm fixation and early mobilization. Open reduction and locking plate fixation are generally chosen [7]. However, in elderly patients, the frequency of complications such as varus deformity and screw penetration due to osteoporosis is high. Especially in combined medial comminuted fractures, loss of fracture reduction occurs more frequently [8, 11]. Therefore, the number of reverse total shoulder arthroplasty cases is increasing in elderly patients [7].

The purpose of this study was to analyze the results of surgical treatment using a locking plate for proximal humeral fractures in patients aged >80 years. Furthermore, we examined the radiological and clinical differences among elderly patients with medial comminuted fractures and complications of plate fixation for proximal humeral fractures.

Methods

This was a retrospective study, and final approval of informed consent exemption by the institutional review board was obtained (IRB NO. 05–2019–013).

Patients who underwent locking plate fixation for the treatment of proximal humeral fracture by the single author at one institution between September 2013 and March of 2016 were included. We performed reverse total shoulder arthroplasty for proximal humeral fractures in patients aged >80 years who had cuff arthropathy or glenohumeral arthritis by using radiography and computed tomography (CT). Twenty-two patients aged >80 years received locking plate fixation for proximal humeral fractures. Among the 22 patients, 3 were excluded, including 2 who died within 1 year after surgery for unrelated causes and one who had a follow-up period of only 8 months. Finally, we retrospectively evaluated 19 patients (4 men and 15 women) who underwent locking plate fixation with proximal humeral fractures within the same period and were followed up for at least 1 year. The mean age at the time of surgery was 82.2 years (range, 80–91 years), and the mean follow-up duration was 15.4 months (range, 12–39 months). By using dual-energy X-ray absorptiometry, we measured the bone density of the patients' hip and spine, which according to the lowest T-score, showed a mean bone mineral density of -2.8 (range, -1.3 to -5.9). According to the Neer classification system, 9 patients had two-part fractures, 8 had three-part fractures, and 2 had four-part fractures (Table 1).

Radiological evaluation was performed immediately and at 2 weeks, 4 weeks, 3 months, 6 months, 9 months, and 12 months after surgery. We defined successful bone union when the fracture site was completely adjoined through callus formation. Humeral neck-shaft angles (NSAs) were measured in the anteroposterior plane. We defined humeral NSA as the angle formed when the angle between the line perpendicular to the articular surface of the fracture bisects the line following the humeral shaft. The humeral NSA was measured preoperatively, postoperatively, and at the final follow-up. Clinical results were compared with University of California, Los Angeles (UCLA), shoulder score, and range of motion was compared with the that of the opposite arm. The results in relation to the medial comminuted fracture and other complications were analyzed.

We used SPSS Statistics ver. 17.0 (SPSS Inc., Chicago, IL, USA) to perform all statistical analyses. The nonparametric Mann-Whitney *U* test was used to analyze the data. The significance threshold was set at 0.05.

Results

Overall clinical results

We achieved successful bone union in all the patients, and the mean time to bone union was 11.4 weeks (range, 12–16 weeks). The humeral NSA at final follow-up was 126.4. The mean UCLA score was 22.4 points and was excellent in 2 patients, good in 5, and poor in 12. Significant differences of 129.2, 112.3,

and 44.2 were found in the mean forward elevation, abduction, and external rotation, respectively. Significant differences were also noted in the internal rotation of L3, as compared with the opposite arm (Table 2).

Comparison of outcomes according to medial comminuted fracture

Seven patients had a medial comminuted fracture. Their mean age was 82.7 years and mean bone density was -4.1. The preoperative NSA was 108.2, postoperative NSA was 130.8, and NSA at final follow-up was 111.4. Twelve patients had no medial comminuted fracture. Their mean age was 82.0 years and mean bone density was -3.7. The NSA was 128.8 before operation, 135.8 just after operation, and 135.1 at final follow-up. We found a statistically significant difference between the preoperative NSA and the NSA at final follow-up. In the group with medial comminuted fractures, the mean range of motion was 108.5 for forward elevation, 99.3 for abduction, and 26.4 for the internal rotation of L2. In the group without medial comminuted fracture, statistically significant differences were noted in forward elevation of 139.4, external rotation of 120.1, internal rotation of 54.5, and internal rotation of L4. The UCLA shoulder score showed significant mean differences of 18.3 and 24.7 in the groups with and without medial comminuted fracture, respectively (Table 3).

Comparison of outcomes according to malreduction of tuberosity

Five patients had malreduction of tuberosity after surgery. Their mean age was 82.6 years and mean bone density was -3.8. Their preoperative NSA was 120.8, postoperative NSA was 134.0, and NSA at final follow-up was 122.0. Fourteen patients had an anatomical reduction. Their mean age was 82.1 years and mean bone density was -3.8. Their preoperative NSA was 121.4; NSA just after the operation, 134.0; and NSA at final follow-up, 128.0. No statistically significant difference was found between the preoperative NSA and NSA at final follow-up. In addition, the clinical results were not satisfactory in the patients with malreduction. However, no statistically significant difference was attained in both groups (Table 4).

Comparison of outcomes according to fracture type

Nine patients had two-part fractures. Their mean age was 81.1 years and mean bone density was -3.8. Their preoperative NSA was 116.2; postoperative NSA, 134.7; and NSA at final follow-up, 127.6. Ten patients had three- or four-part fractures. Their mean age was 83.3 years and mean bone density was -3.8. Their preoperative NSA was 125.8, NSA just after the operation was 133.3, and NSA at final follow-up was 125.3. A statistically significant difference was found between the preoperative NSA and the NSA

at final follow-up. In the group with two-part fractures, the mean range of motion was 132.2 for forward elevation, 115.5 for abduction, and 48.8 for the external and internal rotations of L2. In the group with three- or four-part fractures, no statistically significant differences were observed in the forward elevation of 126.0, abduction of 109.5, external rotation of 40.0, and L2/L3 of internal rotation. The mean UCLA scores of 24.5 and 20.4 for the group with two-part fractures and the group with three- or four-part fractures showed no significant difference (Table 5).

Complications were osteonecrosis in 1 patient and screw penetration in 2 patients. One patient with osteonecrosis was only observed because the pain was not severe, penetrating screw removal was performed in 1 patient, and another patient was not observed.

Discussion

Although various methods such as percutaneous K-wire fixation, plate fixation, and arthroplasty have been proposed for the treatment of proximal humeral fracture with osteoporosis, a definite treatment method has not yet been established [13]. In the case of complications such as infection and destruction of reduction due to weakening of the fixation, pin fixation should be used when bone quality is good and in the absence of a comminuted fracture [1]. In the case of arthroplasty, which is not completely replaceable with other surgical procedures, the incidence rate of complications such as dislocation, nerve damage, and infection ranges from 5% to 40% [16].

Especially in the case of fractures without medial support, varus deformity and loss of fracture were reported. The reason for this is that medial comminuted fracture is associated with blood flow injury, poor bone quality, and high energy damage [10]. The authors also reported that varus deformity was more severe in the medial comminuted fractures. After operation, we achieved restoration of the NSA but found no statistically significant difference at final follow-up. Clinical results also showed decreases in the range of motion and clinical performance. For this reason, Gardner et al. [12] proposed a fibular strut allograft augmentation and reported good results when the medial support was difficult. It is often accompanied by shoulder stiffness and scapular dyskinesia after proximal humeral fracture. Thus, various rehabilitation methods have been introduced to prevent this [4, 15]. Aggressive rehabilitation can reduce the many discomforts associated with stiffness. The authors presented various exercise methods to patients, including scapular, stretching, and strengthening exercises. However, in elderly patients, compliance was poor and aggressive rehabilitation was difficult because of pain, and these factors are also considered to contribute to the poor clinical outcome.

Open plate fixation was generally good, but complication and reoperation rates of 15% and 12.7% were reported, respectively [3]. Various complications such as malunion, loss of fracture reduction, metal failure, nonunion, and osteonecrosis have been reported. In 8% of patients, screw penetration was the most common cause of reoperation [9]. Two patients had screw penetration, one of whom had reoperation to remove the screw. To prevent this, evaluation of bone quality of the patient, accurate analysis of the fracture type, plate selection, proper screw fixation, and so on should be predicted and

prepared beforehand. Especially during the operation, the length of the screw should be examined using C-arm imaging. Furthermore, the far-cortex should be measured with a depth gage, based on which the screw length can be decided. The incidence rate of osteonecrosis after surgical treatment of proximal humeral fractures is reported to be 3–35% [14]. Especially in the proximal humeral head, after 48 hours, the frequency of this increase is high. In these patients, the frequency of shifting to arthroplasty was high. The authors also performed surgical treatment in 1 patient on postoperative day 4, which resulted in osteonecrosis. In this patient, pain and discomfort were considered in the arthroplasty. However, owing to the age of the elderly patient, conservative treatment was considered more suitable.

Recently, the number of reverse total shoulder arthroplasty cases has been increasing among complex humeral fractures. The results are excellent as compared with those of hemiarthroplasty, and the 5- and 10-year survival rates are 94% and 91%, respectively. However, the technique of reverse total shoulder arthroplasty for fractures was found to be more difficult than the procedure for rotator cuff disease, and the functional score decreased from 6 years after the procedure, so that the constant score was maintained at ≥ 30 points in 60% of patients only [5]. Generally, the complication rate of reverse total shoulder arthroplasty is reported to be 19–68%. Therefore, reverse total shoulder arthroplasty is not an easy choice for treating proximal humeral fractures even in the elderly [2].

Conclusions

In the surgical treatment of proximal humeral fractures in patients aged >80 years, use of a locking plate attained bone union with relatively satisfactory results. However, we considered that prevention of and training for postoperative stiffness are necessary. Other surgical methods should be considered for patients with complex displaced fractures, especially those with medial comminuted fractures.

Abbreviations

UCLA score (University of California, Los Angeles, shoulder score), NSA (neck-shaft angle), CT (computed tomography)

Declarations

This was a retrospective study, and final approval of informed consent exemption by the institutional review board was obtained (IRB NO. 05–2019–013).

Consent to publish: We obtained consent for publication

Availability of data and materials: The datasets used and/or analyzed during the current study

are available from the corresponding author on reasonable request.

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WCS: 1st author, data analysis

SWK: Corresponding author, data analysis

SMS: Statistical support

HB: Data analysis

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Tables

Due to technical limitations, tables are available for download in supplementary section.

Figures

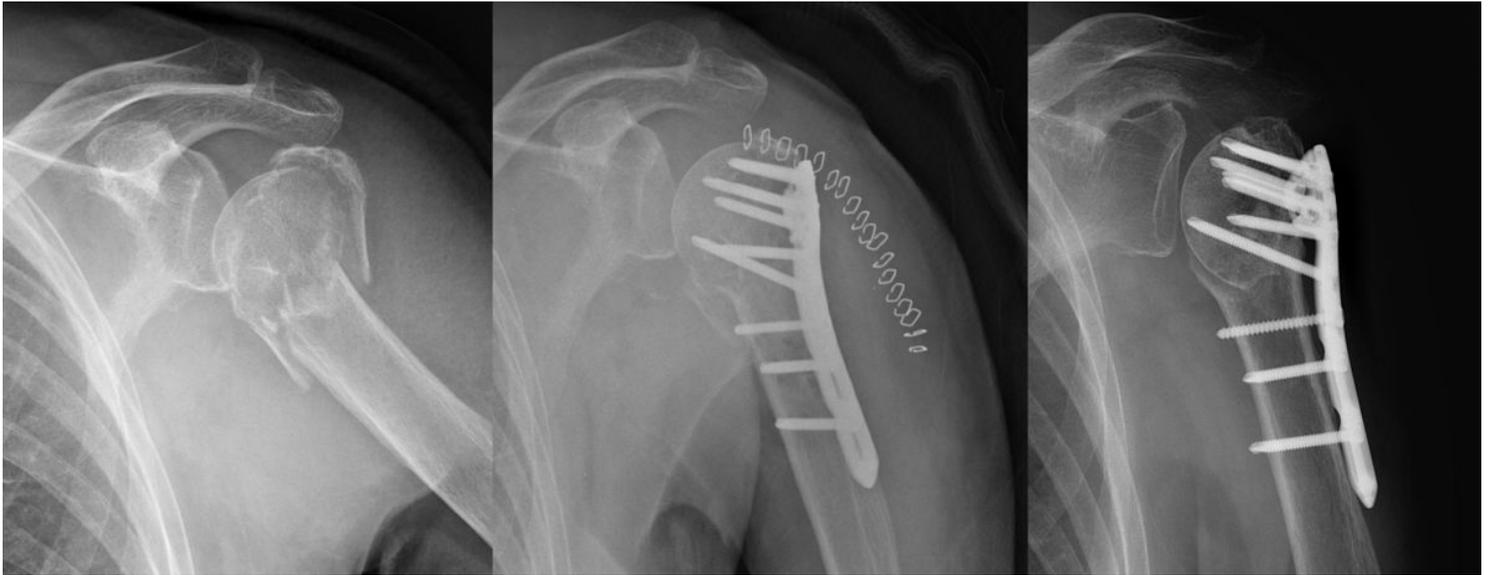


Figure 1

A–C. Radiography of the Left shoulder in a 85-year-old patient A. Preoperative anteroposterior radiograph showing medial comminuted fracture Figure 1-B. Postoperative anteroposterior radiograph C. Postoperative anteroposterior radiograph showing varus deformity at the 12-month follow-up

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