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The Outcomes of Proximal Humerus Fractures with Medial Metaphyseal Disruption Treated with Fibular Allograft Augmentation and Locking Plate

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Background: Proximal humerus fracture is considered to be the third most common fracture for patients aged 65 years or older. Conservative treatment has been known to treat most of humerus fracture. However, fractures with severe displacement or dislocation may require surgical treatment. Intramedullary fibular allograft with a locking plate is frequently used in patients accompanying medial metaphyseal disruption. In this study, author intends to evaluate clinical and imaging results based on patients who underwent surgical treatment using fibular allograft with a locking plate.

Methods: This study is conducted prospectively at Wonju Severance Christian Hospital, targeting patients who previously underwent surgical treatment using open reduction and intramedullary fibular allograft with a locking plate between 2011 and 2015. A total of 26 patients were evaluated on the following: postoperational clinical assessment measuring Constant score, American Shoulder and Elbow Society (ASES) score, and the Disabilities of the Arm, Shoulder and Hand (DASH) score. Postoperational imaging assessments are evaluated via measuring the neck-shaft angle. The study subject were Neer classification type 3, 4 proximal humerus fracture cases with disrupted medial hinge and having cortical comminution in the region of the surgical neck.

Results: The average period of progression was 22.5 months, and the average age of patients was 72.6 years. At the final follow-up, the average Constant, average ASES, and average DASH scores were 80.1, 78.5, and 20.6 respectively. The average neck-shaft angle was 127.5°.

Conclusions: In conclusion, fibular allograft augmentation with a locking plate showed satisfying results in both clinical and imaging studies.

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Key Words: Fibular allograft; Locking plate; Proximal humerus fractures

Introduction

Proximal humerus fracture accounts for approximately 4% to 5% of total fractures and is known to be the third most common fracture for patients aged 65 years or older.[1-3] Conservative treatments are considered for most cases of humerus fractures. However, in cases of severe fracture and dislocation, surgical treatment may be required for stable fixation and reduction.[4,5] There are several known surgical treatments for humeral fractures, including closed reduction and percutaneous fixation, open reduction and internal fixation with plate, intramedullary nail fixation, hemiarthroplasty, such as transosseus suture fixation, and other several methods are known.[6-8] Among these, open reduction and internal fixation with locking-plate techniques are known to exhibit good results, and they are known to result in satisfactory outcomes when compared with techniques that use conventional plate in proximal humerus fractures.[9-11] However, as reported previously, some complications, such as

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varus collapse and screw pull-out, may occur, in 9% to 40% of cases, when there is medial metaphyseal comminution or osteoporotic bone.[12-15] Therefore, open reduction and locking plate techniques have been used through the intramedullary fibular allograft to reduce such complications. Fibular allograft with a locking plate technique may possibly prevent additional medial support and varus malalignment. Thus, these techniques have been used well in the medial metaphyseal disruption and osteoporotic bone, and as a result, considered to be good.[16-18] However, to date, only a few studies have been conducted in Korea investigating the clinical and imaging results based on patients who underwent surgical treatment using fibular allograft with a locking plate.

Methods

This study is conducted retrospectively in Wonju Severance Christian Hospital, specifically targeting patients who underwent surgical treatment using open reduction and intramedullay fibular allograft with a locking plate between 2011 and 2015. The study included 26 patients (man: 8, women: 18), and the average age was 72.6 years (range 59–89 years). The average additional test period was 22.5 months (range, 12–38 months), and follow-up continued up to an year after surgery–follow-up loss up within an year after surgery were excluded. Preoperative evaluation was conducted using shoulder anteroposterior (AP), lateral x-ray photos, and computed tomography imaging, and the Neer classification was evaluated using the fracture type.[19,20] Using the Neer classification, 10 patients were classified as 3-part fractures and 16 patients were classified as 4-part fractures. In injury mechanism, 16 patients were slip down injury, 8 patients were traffic accident, and two patients were fall down injury (Table 1). Postoperative clinical evaluation was assessed, measuring the Constant-Murley Shoulder Outcome (Constant) score, American Shoulder and Elbow Society (ASES) score, and the Disabilities of the Arm, Shoulder and Hand (DASH) score. At the final follow-up, functional outcome assessment was performed using the Constant score. The Constant score was graded as poor (0–55 points), moderate (56–70 points), good (71–85 points), and excellent (86–100 points).[21] Moreover, the above 3 scores on the non-fractured side (normal side) were measured, and both sides were compared. The analysis of variance (independent t-test) was used for statistical analysis. The p-value <0.05 was considered as significant difference. Postoperative imaging evaluation was assessed by measuring the angle between humeral head and shaft (humeral neck-shaft angle) in the shoulder AP plain view. The inclusion criteria were as follows: Neer classification type 3, 4 proximal humerus fracture with disrupted medial hinge, and having a cortical comminution in the region of the surgical neck. Exclusion criteria were as follows: past history of shoulder surgery, open fractures, unreconstructable head, and/or tuberosity fragments. Those who later refused to participate or failed to cooperate were also excluded. All participating subjects provided informed consent, and the protocol of this study was approved by our institutional review board.

Table 1. Basic Patient Information

Variable	Value
Total case	26
Mean age (yr)	72.6 ± 7.9
Sex (male:female)	8:18
Mean follow-up period (mo)	22.5 ± 7.6
Fracture type (Neer classification)	
3-part	10
4-part	16
Injury mechanism	
Slip down	16
Traffic accident	8
Falling down	2

Values are presented as number only or mean ± standard deviation.

Surgical Technique

All surgeries were performed at Wonju Severance Christian Hospital and implemented by a single author. Surgery was prepared by placing the patient in general anesthesia via the beach chair position. The deltopectoral approach was carried out in 20 patients, and deltoid-splitting approach was carried out in 6 patients. After exposing the proximal humerus, No. 5 Ethi-bonds, located in the rotator cuff tendon, were used to implement the traction and the reduction process was carried out in joystick technique using Kirschner wires and Spinal elevator. After inserting the fibular allograft through the subsequent humeral canal, indirect reduction of the medial column is carried out, while managing the medialization as much as possible. After confirming the anatomical reduction by the C-arm, the proximal humeral locking plate (Philos plate; Synthes, Oberdorf, Switzerland) was fixated 2 mm lateral of the bicipital groove and 5 mm distal of the Greater tubercle. Then No. 5 Ethi-bonds with traction was conducted, which helped to maintain the reduction (Fig. 1).

Results

At the final follow-up, the average Constant, ASES, and DASH scores were 80.1 points (range, 53–97 points), 78.5 points (range, 51.6–93.3 points), and 20.6 points (range, 11.7–41.0 points), respectively. The average neck-shaft angle was 127.5° (range, 115°–139°) (Table 2). Twelve patients had excellent scores, 9 patients had good scores, 4 patients had moderate scores, and 1 patient had a poor score. Moreover, on the normal side, the

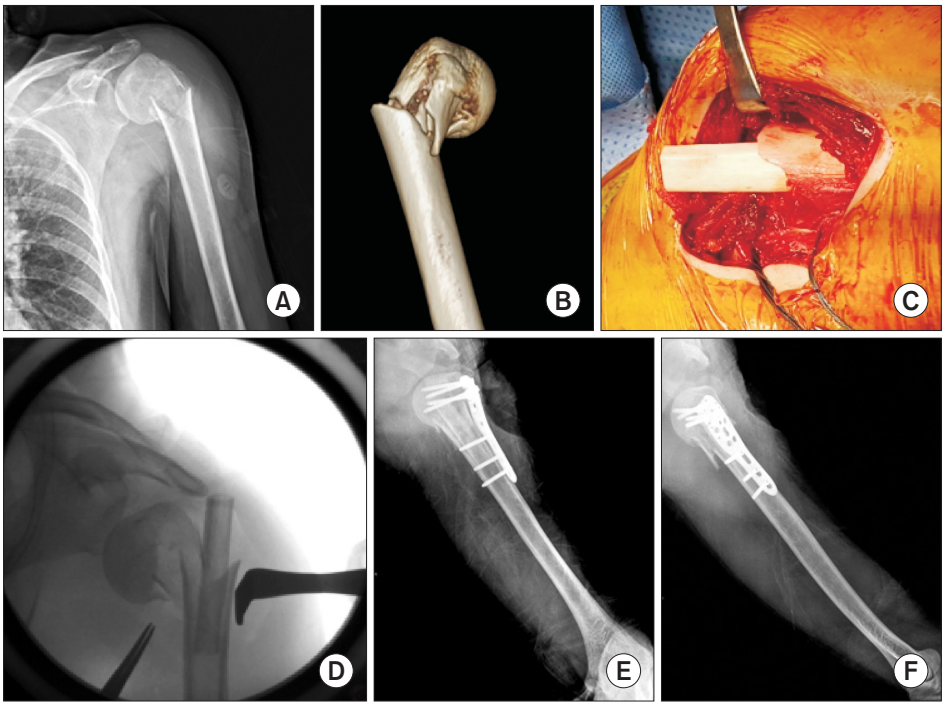

Fig. 1. (A, B) Anteroposterior x-ray and computed tomography scan show Neer three-part fracture with metaphyseal disruption. (C, D) A fibular allograft was inserted and indirectly reduction of the medial column was carried out in the humeral canal under c-arm guidance. (E, F) Postoperative humerus anteroposterior and lateral x-rays.

Table 2. Postoperative Clinical and Radiological Results

Variable	Value
Mean Constant score	80.1 ± 14.0
Mean ASES score	78.5 ± 11.7
Mean DASH score	20.6 ± 8.9
Mean neck-shaft angle (°)	127.5 ± 7.9

Values are presented as mean ± standard deviation.
Constant: Constant-Murley Shoulder Outcome, ASES: American Shoulder and Elbow Society, DASH: Disabilities of the Arm, Shoulder and Hand.

Table 3. Comparison between Fracture Side and Normal Side

Variable	Fracture side	Normal side	*p*-value
Mean Constant score	80.1 ± 14.0	82.3 ± 10.7	0.603
Mean ASES score	78.5 ± 11.7	80.1 ± 12.2	0.566
Mean DASH score	20.6 ± 8.9	19.8 ± 8.4	0.725

Values are presented as mean ± standard deviation.
Constant: Constant-Murley Shoulder Outcome, ASES: American Shoulder and Elbow Society, DASH: Disabilities of the Arm, Shoulder and Hand.

average Constant score, average ASES score, and average DASH score were 82.3 points (range, 64–98 points), 80.1 points (range, 48.3–96.6 points), and 19.8 points (range, 9.2–40.0 points). The scores of the normal side was better than those of the fracture side; however, there was no statistically significant difference between the two groups when the scores were compared by an independent t-test (Table 3). All patients had been considered healed according to the clinical and imaging studies. As for postoperative complications, there was 1 case of early postoperative infection, which improved after 4 weeks of oral antibiotic treatment. Moreover, there was one case of varus displacement of 11°, which was kept under observation. One patient underwent reverse total shoulder arthroplasty due to cuff tear arthropathy three years after the operation. There were no major complications, such as loosening of implant and screw, neurovascular injury, and avascular necrosis of humeral head.

Discussion

Proximal humerus fracture is known to be most common in elderly patients following hip fracture and distal radius fracture.[2] Although most proximal humerus fractures are treatable by conservative treatment, those with unstable proximal humerus fractures, 3-part fracture, 4-part fracture, or medial metaphyseal disruption frequently undergo locking plate and fibular surgical treatments using allograft augmentation.[16,17] Chow et al.[22] explained how fibula allograft augmentation withstood the repetitive varus loading using the cadevaric specimens. Furthermore, when using fibular allograft augmentation, compared with when using only the locking compression plate, it was confirmed that the former can withstand greater loads.[22] In aclinical study, Walch et al.[23] first reported satisfactory results by cancellous bone grafting of nonunion surgical neck of the humerus by intramedullary bone peg. Recently Tan et al.[24] announced satisfactory results in 9 elderly patients with proximal humerus fracture by a fibular strut graft. On the basis of the results from these studies,

we thought the fibular allograft augmentation would be a sufficient medial support, increasing the strength in the proximal humerus fracture in obtaining high stability. Therefore, we investigated the clinical and imaging consequences of therapy using a locking compression plate and fibular allograft augmentation in unstable proximal humerus fractures. We conducted open reduction and internal fixation using a locking compression plate and fibular allograft augmentation in 13 patients with unstable proximal humerus fractures. As a result, we obtained relatively satisfying outcomes of clinical and imaginary studies, and there were no severe complications, such as non-union, screw penetration, and humeral head collapse. However, the study had a few limitations. First, we could not conduct other treatments to compare the study with similar cases of fracture. It would have been a better study if the study included a control group of not using fibular allograft augmentation. Second, the study was conducted without differentiating the dominant arm from the non-dominant arm. This would make a gap between clinical results. Further studies that compensate these limitations are necessary.

Conclusion

In conclusion, fibular allograft augmentation with a locking plate showed satisfying results in both clinical and imaging studies. We believe this technique will be a fine treatment in proximal humerus fractures with metaphyseal disruption, enhancing medical support and stability.

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