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ORIGINAL ARTICLE

Treatment of comminuted proximal humeral fractures using locking plate with strut allograft

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Background: This study compared the radiologic outcome of fixation using locking plate only with fixation using locking plate with an endosteal strut allograft in the treatment of comminuted proximal humeral fracture.

Methods: Among 52 patients with comminuted proximal humeral fracture, 32 patients underwent fixation with locking plate only, and 20 patients underwent fixation using locking plate with an endosteal strut allograft. The strut allograft was inserted into the intramedullary cavity of the humerus to support the humeral head and fixed with the locking plate. Immediate postoperative radiologic findings were compared with those of 6 months or more after the surgery, and loss of anatomic fixation was defined if the varus malalignment of neck-shaft angle (NSA) was more than 5° or if the change of humeral head height (HHH) was more than 3 mm.

Results: In the locking plate-only group, 22 of 32 patients (69%) showed the change in NSA of more than 5°, with an average of 10.2°. The HHH change in 20 patients (62.5%) was more than 3 mm, with an average of 4 mm. Among 20 patients who underwent locking plate with the endosteal strut allograft, the average NSA and HHH change was 3° and 1 mm, respectively. Varus malalignment was evident in 2 patients (10%). The HHH change was more than 3 mm in 1 patient (5%).

Conclusion: Fixation using a locking plate with an endosteal strut allograft can be considered a reasonable option to maintain the anatomic reduction in elderly patients with comminuted proximal humeral fracture.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

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Keywords: Proximal humerus; comminuted fracture; allograft; locking plate; neck-shaft angle; humeral head height

The Institutional Review Board (IRB No.: VIRB-00122_1-014) of St. Vincent's Hospital, the Catholic University of Korea, approved this study (Study No.: VC14RISI0159).

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Comminuted fracture of the proximal humerus is a common type of fracture in those with insufficient bone quality, such as elderly patients and patients with osteoporosis, and obtaining and maintaining satisfactory fixation and bony union after surgery is not easy.¹⁹ Arthroplasty can be applied for elderly patients with a comminuted humeral fracture of more than 3 parts,^{21,22} but the satisfactory result of arthroplasty is

hard to achieve because of its frequent association with comminution in the greater tuberosity and osteoporosis. If fixation of the greater tuberosity, which is important in functional recovery after arthroplasty, cannot be achieved, recovery of function is not likely. Although reverse shoulder arthroplasty can be suggested as an alternative option, this application should be prudent after consideration because the reported rate of complications is very high.⁵

The recent introduction of the locking plate has made it easier to achieve the maintenance of fixation of proximal humeral fracture.^{24,25} But in the case of weak bone quality, complications are often reported, including loosening of screws fixed on plate from the bone, varus malalignment, screw cutout, and penetration into the joint.^{8,11,13,14,19,22} To overcome such problems, adding a bone graft, including an intramedullary allograft, has been performed, and good outcomes have been described. However, the number of patients in several articles is yet to be achieved.^{9,11,19}

This study compared the radiologic outcome of fixation using locking plate only with fixation using locking plate along with an endosteal strut allograft in the treatment of comminuted fracture of the proximal humerus.

Materials and methods

This retrospective case study enrolled 52 patients (13 men and 39 women) who underwent a surgical procedure for comminuted proximal humeral fracture between September 2008 and May 2014. The average age was 69.1 years (range, 55-87 years). Thirty-two patients underwent fixation with locking plate only (group A) and 20 underwent fixation using locking plate with an endosteal strut allograft (group B). The average ages were 67.8 years (range, 55-87 years) in group A (8 men, 24 women) and 71.3 years (range, 55-85 years) in group B (5 men, 15 women). By the Neer classification, there were 8 type II (5 with metaphyseal comminution), 21 type III (5 with metaphyseal comminution), and 3 type IV fractures in group A and 3 type II (all with metaphyseal comminution), 15 (8 with metaphyseal comminution) type III, and 2 type IV (1 with metaphyseal comminution) fractures in group B.

All operations were performed by a senior shoulder surgeon (J.J.). The surgery was performed through the deltopectoral approach. A PHILOS Proximal Humerus Internal Locking System (Synthes, Mezzovico-Vira, Switzerland) was used as a locking plate.

The average follow-up period was 15 months (range, 12-28 months), and radiologic evaluation was done by measuring neck-shaft angle (NSA) on anteroposterior or Grashey view and by measuring humeral head height (HHH), as previously proposed¹² (Fig. 1). HHH was defined as the distance between the upper end of the plate and the upper end of the humeral head. Measurements were done by orthopedic surgeons unaware of the purpose and the content of the study and were performed using a picture archiving and communication system measurement tool. Loss of anatomic fixation was defined if, in the comparison of immediate postoperative radiologic findings with those of 6 months or more after the surgery, the varus change of NSA was more than 5° or if the change of HHH was more than 3 mm.

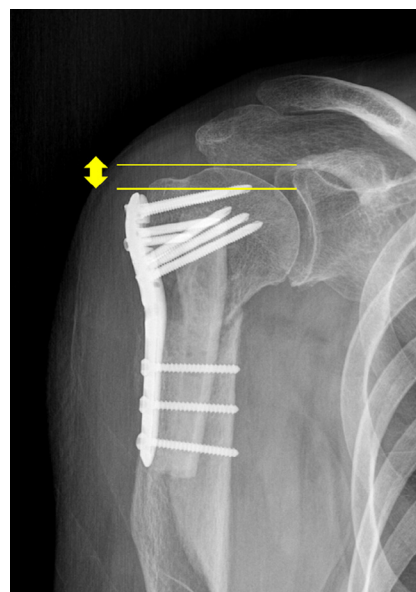


Figure 1 Humeral head height is defined as the distance between most upper head of humerus and most upper edge of plate.

Surgical technique of the locking plate with strut allograft

The surgery was performed through the deltopectoral approach.²⁴ Several Ethibond No 2-0 sutures (Ethicon, Somerville, NJ, USA) were passed through suprascapularis, infraspinatus, and subscapularis muscles and manipulated for easier maneuverability of the tuberosity and humeral head fragment. If the reduction was difficult and was considered less likely to be maintained because of weak bone quality or comminution, a strut allograft was used.^{8,11,13,14,19,22} Eleven deep frozen allografts (2 fibulae, 4 ulnae, and 5 radius) were obtained from the bone bank of our hospital and were sterilized by gamma-radiation with 2.5 kGy. Nine (1 fibula, 2 ulnae, and 6 radius) were commercially obtained deep frozen allografts that had not been gamma-radiated. A strut allograft was inserted into the intramedullary cavity of the fracture site and pushed medially and superiorly so that the medial cortical continuity and the height of the proximal humerus could be recovered in the anatomical position. The reduction was maintained by temporary Kirschner wire fixation while the length and angle between humeral head and neck were checked with fluoroscopy.

Gardner et al¹¹ introduced the use of a push screw to medialize the strut allograft so that the graft could make contact with fractured medial cortex and get reduction. However, in most cases, we were able to obtain the medial reduction without using push screw. Pushing the graft upward instead of medial resulted in anatomic reduction of humeral head because it could support the humeral head and fractured segments in a proper height and position in the intramedullary cavity as in retrograded intramedullary nailing.

After the confirmation of fracture reduction under image intensifier, the PHILOS Proximal Humerus Internal Locking System was positioned on the lateral cortex and fixed with locking and cortical screws. At least 1 or 2 screws penetrated into the graft, and 2 locking screws were fixed toward the inferomedial cortical bone of the proximal humerus to support the reduction.^{11,13}

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