



## TREATMENT OF COMMINUTED PROXIMAL HUMERAL FRACTURES USING LOCKING PLATE WITH STRUT ALLOGRAFT

Jinyoung Jeong\*

St. Vincent's hospital, The Catholic University of Korea, Suwon, 16247, South Korea

### ARTICLE INFO

Published: 26<sup>th</sup> August 2018  
\*Corresponding author:  
Jinyoung Jeong  
email:  
osjeong@hotmail.com

### KEYWORDS

Proximal humerus;  
Comminuted fracture;  
Allograft;  
Locking plate;  
Neck-shaft angle;  
Humeral head height

### SUMMARY

Fixation of the comminuted proximal humeral fractures using plate is not easy and difficult to maintain. We hypothesized that the augmentation with endosteal strut allograft should be better to maintain the fixation and evaluated the result of treatment for the comminuted proximal humeral fracture by using plate and endosteal strut allograft to prevent fixation failure with a locking plate. The fixation using locking plate with endosteal strut allograft can be considered a reasonable option to maintain the anatomical reduction in the elderly patients with comminuted proximal humeral fracture.

### 1.0 Introduction

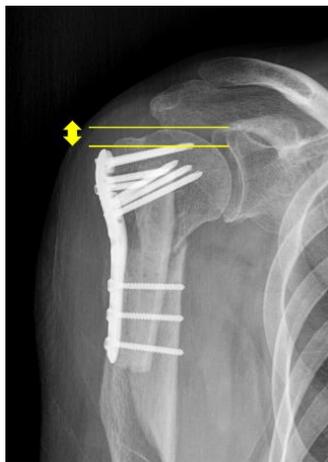
Comminuted fracture of the proximal humerus is a common type of fracture in those with insufficient bone quality, such as elderly patients and patients with osteoporosis, and is not easy to obtain and maintain satisfactory fixation and bony union after surgery<sup>1</sup>. Arthroplasty can be applied for elderly patients with comminuted humeral fracture more than three parts<sup>2,3</sup> but the satisfactory result of arthroplasty is hard to achieved due to its frequent association with comminution in the greater tuberosity and osteoporosis. If the fixation of greater tuberosity, which is important in functional recovery after arthroplasty, cannot be achieved the recovery of function is hard to be likely. Although reverse shoulder arthroplasty can be suggested as an alternative option, this application should be prudent after consideration since the reported rate of complications are very high yet.

Recently, the introduction of locking plate has made it easier to achieve the maintenance of fixation of proximal humeral fracture<sup>4,5</sup>. But in the case of weak bone quality, complications such as loosening of screws fixed on plate from the bone, varus malalignment, screw cutout and penetration into the joint are often reported<sup>1,3</sup>. To overcome such problems, adding bone graft including intramedullary allograft has been performed and good outcomes have been described. However, the number of cases in several articles is yet to be achieved<sup>1</sup>.

### 2.0 Materials and Method

This retrospective case study enrolled 52 patients (13 males, 39 females) who underwent 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 endosteal strut allograft (group B). The average age of group A

(8 males, 24 females) was 67.8 years (range, 55-87 years). The average age of group B (5 males, 15 females) was 71.3 years (range, 55-85 years). In terms of 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 surgeries were performed by a senior shoulder surgeon (JJ). The surgery was performed through the deltopectoral approach using 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 on anteroposterior (AP) or Grashey view, and by measuring humeral head height as previously proposed<sup>12</sup> (Fig. 1). Humeral head height was defined as the distance between the upper end of the plate and the upper end of humeral head. Measurements were done by orthopedic surgeons unaware of the purpose and the content of the study and were performed using a PACS (picture archiving & communication system) measurement tool. Loss of anatomical fixation was defined if, in the comparison of immediate post-operative radiologic findings with those of 6 months or more after the surgery, the varus change of neck-shaft angle was more than 5 degrees or if the change of humeral head height was more than 3 mm.



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

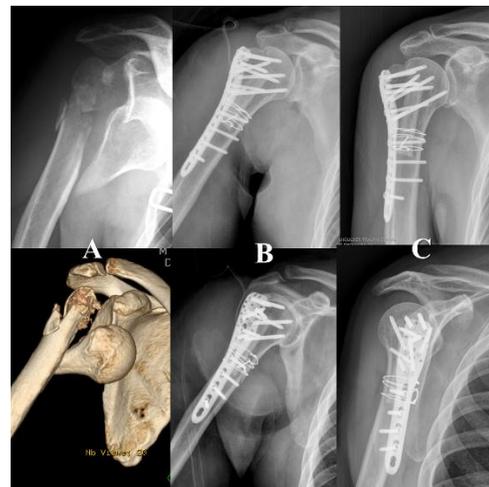
### 3.0 Results

In the locking plate only group, 22 out of 32 cases (69%) showed the change in NSA of more than 5 degrees, with an average of 10.2 degrees. Twenty cases (62.5%) had the change of HHH more than 3 mm, with an average of 4.4 mm. Among 20 cases that underwent locking plate with endosteal strut

allograft, the average NSA and HHH change was 2.7 degrees and 1.2 mm, respectively. Varus malalignment was evident in 2 cases (10%). One case (5%) displayed HHH change more than 3 mm (Table 1).

**Table 1** Comparison between locking plate group and locking plate with endosteal strut allograft group (SD; standard deviation).

Variable	Group	Mean	SD	Range	P value
Neck-Shaft Angle (degree)	Locking plate only	10.2	6.7	0-30	<0.001
	Locking plate with strut allograft	2.7	2.6	0-8	
Humeral head height (mm)	Locking plate only	4.4	3.6	0-13	<0.001
	Locking plate with strut allograft	1.2	0.9	0-3	



**Fig 2.** A. An x-ray and CT scan of 73-year-old male patient showed a comminuted fracture at the proximal humerus with dislocation. B. Immediate postoperative plain radiograph showed the good metaphyseal & humeral head support by the endosteal strut allograft and locking plate C. On an x-ray taken 12 months postoperatively the neck-shaft angle and humeral head height were maintained, and the fracture healed

### 4.0 Discussion & Conclusion

For the internal fixation of a 2-part fracture of the proximal humerus, intramedullary rod, rigid angle devices, side-plate and screw, tension band wiring and suture fixations are chosen as treatment options. However, there are difficulties in selecting treatment options for 3 or 4 part fracture with comminuted proximal humerus, and the standard non-locking plate does not provide adequate fixation power for 3- and 4-part fractures, and often results in complications, such as screw loosening and screw pull-out. Meier et al. performed surgery for proximal humerus fracture by using a 3.5 mm 110° blade plate, but reported that 22% of patients showed complications in which the blade penetrated the humeral head so the results

were not satisfactory. After the introduction of locking plate system, relatively stable fixation of plate on 3- or 4-part fracture can be achieved and it is widely-used nowadays<sup>24</sup>. Locking plate theoretically can provide screw fixation angle in multi-direction and locking screws on plate so that the fracture reduction and fixation maintenance can be provided, even with comminution and osteoporosis of the proximal humerus. Walsh et al. reported the superiority of the fixation power of locking plate over that of standard non-locking plate in cadaveric study. But many authors<sup>1,3</sup>, still reported several complications, such as varus malalignment, screw cutout, articular penetration, osteonecrosis and infection, despite the use of locking plate in elderly patients and the rate of complications of locking plate in elderly patients ranged from 9% to 36%. In this study, 22 of 32 cases (69%) showed the change in NSA more than 5 degrees, with the average of 10.2 degrees. Twenty cases (62.5%) had the change of HHH more than 3 mm, with the average of 4.4 mm. Gardner et al.<sup>12</sup> tried to prevent these complications by instilling calcium phosphate into the defect and cement augmentation, but the results were not satisfactory. They then first introduced the locking plate fixation with the use of fibular strut allograft. The recovery of normal anatomical height of humeral head could be achieved by using fibular strut allograft as a medial buttress and the fracture reduction could be easily achieved by strut allograft so that it could prevent potential varus malalignment. Neviasser et al.<sup>3</sup> reported a low rate of complications that included reduction failure (2.6%), screw cutout (0%) and osteonecrosis (2.6%) by using locking plate fixation with endosteal strut allograft in 38 patients with proximal humeral fracture; clinical results were satisfactory. Matassi et al.<sup>19</sup> reported that no more than 2 mm collapse of the humeral head height and no other complications, such as osteonecrosis or intra-articular screw penetrations, in locking plate fixation with fibular strut allograft in 17 patients with proximal humeral fracture combined with medial buttress comminution. In this study as well, the rate of varus malalignment and humeral head height loss significantly decreased to 10% and 5%, respectively, when accompanied by an endosteal strut allograft. Gardner et al.<sup>7</sup> introduced medialization of strut allograft by using push screw for the reduction of medial cortical bone of proximal humerus. However, the authors were able to obtain the medial reduction without using a push screw. Instead of using allograft for initial reduction of medial cortex, the allograft was pulled upward in the intramedullary cavity to maintain and support the length of humeral head and neck so that the reduction of medial cortex was obtained subsequently, and allograft was screwed together with humeral cortex to expect the maintenance of reduction till the bone union. Especially in cases of severe comminution of humeral neck including medial cortex, it is thought that the medial buttress alone is not sufficient for the achievement and maintenance of fracture reduction, and that using allograft as a

pillar that supports the humeral head from intramedullary cavity is more helpful in maintaining fracture reduction. Our results also showed that fractures combined with metaphyseal comminution tend to have a more varus malalignment in the locking plate only group, whereas there was no change in the locking plate with endosteal strut allograft group.

Although allograft has negative aspects such as disease transmission, risk of infection and immune reaction, these risks can be reduced through selection of suitable donors and aseptic management in processing. Allografts from our tissue bank were irradiated at 2.5 kGy, which may have contributed to further safety in using allograft. In fact in this study, no case of disease transmission or infection was reported in treatment with endosteal strut allograft. Matassi et al.<sup>1</sup> reported 1 superficial infection out of 17 patients, and Neviasser et al.<sup>3</sup> reported 1 infection out of 38 that was treated without complication after prescription of 2 weeks of oral antibiotics. For other complications, since allograft is harder than autograft, the breakage of drill bit while inserting screw and fracture of allograft could happen, and the matter of extra cost should be given attention. There might be a possibility of difficulty in reaming or revision procedures for the intramedullary canal in the future since the intramedullary graft was incorporated in the canal. Therefore, we need to apply this procedure to the selected cases with caution and recommend using as shorter length of allograft as possible to reduce these difficulties of the future intramedullary procedures.

In treating comminuted proximal humeral fracture, fixation using locking plate alongside with endosteal strut allograft is one of the treatment options that shows satisfactory result in humeral head support and maintenance of reduction, and it is expected to minimize the complications that may happen while performing fixation with locking plate only and trigger early rehabilitation.

## References

1. Matassi F, Angeloni R, Carulli C, Civinini R, Di Bella L, Redl B, et al. Locking plate and fibular allograft augmentation in unstable fractures of proximal humerus. *Injury*. 2012;43:1939-42.
2. Neer CS, 2nd. Displaced proximal humeral fractures. II. Treatment of three-part and four-part displacement. *J Bone Joint Surg Am*. 1970;52:1090-103.
3. Neviasser AS, Hettrich CM, Beamer BS, Dines JS, Lorch DG. Endosteal strut augment reduces complications associated with proximal humeral locking plates. *Clin Orthop Relat Res*. 2011;469:3300-6.