Tzu Chi Medical Journal 24 (2012) 131–135

Contents lists available at SciVerse ScienceDirect

Tzu Chi Medical Journal

journal homepage: www.tzuchimedjnl.com

Original Article

Surgical treatment for proximal humeral fracture in elderly patients with emphasis on the use of intramedullary strut allografts

Cheng-Huan Peng [a], Wen-Tien Wu [a,b], Tzai-Chiu Yu [a,b], Li-Chun Chen [c], Shih-Hsiang Hsu [a,b], Sai-Tung Kwong [a], Ting-Kuo Yao [a], Kun-Chi Wu [a,b], Po-Chou Shao [a], Jen-Hung Wang [d], Ing-Ho Chen [a,b,*]

[a] Department of Orthopedics, Buddhist Tzu Chi General Hospital, Hualien, Taiwan
[b] School of Medicine, Tzu Chi University, Hualien, Taiwan
[c] Department of Physical Medicine and Rehabilitation, Buddhist Tzu Chi General Hospital, Hualien, Taiwan
[d] Department of Medical Research, Buddhist Tzu Chi General Hospital, Hualien, Taiwan

ARTICLE INFO

Article history:
Received 26 June 2012
Received in revised form
10 July 2012
Accepted 19 July 2012

Keywords:
Humeral head height
Intramedullary strut allograft
Neck-shaft angle
Proximal humeral fracture
Varus collapse

ABSTRACT

Objective: To review the results of proximal humeral fracture in elderly patients receiving open reduction and internal fixation (ORIF), and to investigate whether use of intramedullary strut allografts leads to better outcomes.

Methods: Retrospective review of radiographs, charts, and surgical records of 90 patients, age 65 years and older, followed up for a minimum of 12 months after buttress plate fixation of a proximal humeral fracture from January 2001 to March 2011. The fractures were reduced with or without insertion of an intramedullary strut allograft during the operation. We analyzed overall results, fracture union status, and varus collapse (by determining the change in the neck-shaft angle and humeral head height) by radiography at 5 different time points: immediately and 1, 3, 6, and, 12 months postoperative.

Results: The 90 patients enrolled in the study included 24 men and 66 women. An intramedullary strut allograft was applied in 55 patients (BG group), and not applied in the remaining 35 patients (non-BG group). Overall favorable union was achieved in 72.2 % (65 of 90) of patients, with malunion in 20% (18 of 90) and nonunion in 7.8% (7 of 90). There were no significant differences between patients with satisfactory and unsatisfactory outcomes in terms of age or gender. The percentage of satisfactory outcomes was clearly higher in the BG group (92.73% vs. 40%, $p < 0.001$). Ironically, better outcomes were obtained in the severe group (Neer 3-, and 4-part fractures) than the minor group (Neer 2-part fractures) (82.98% vs. 60.47% $p = 0.017$). The degrees of loss of reduction with the use or nonuse of intramedullary strut allografts in the favorable union and malunion groups were compared. The amount of loss of reduction in the neck-shaft angle was significantly lower in the BG group than the non-BG group (2.43° vs. 11.11°, $p < 0.001$). The amount of loss of reduction in humeral head collapse was significantly lower in the BG group than the non-BG group (2.05 mm vs. 6.01 mm, $p < 0.001$).

Conclusions: Complications after treating proximal humeral fracture in the elderly are frequently encountered because of poor bone quality. When fixing the fracture with plates, adjuvant use of intramedullary strut allograft can significantly enhance the result and reduce the incidence of malunion, nonunion and varus collapse.

1. Introduction

Proximal humeral fractures account for 5% to 8% of all fractures [1–3]. It is the fourth most common fracture following hip, spine, and wrist fractures in elderly osteoporotic patients who have low-energy accidents [4]. Conservative treatment for nondisplaced or minimally displaced proximal humeral fractures is suggested and good outcomes can be achieved [5]. Caution is needed when applying nonsurgical treatment in displaced proximal humeral fractures, as unsatisfactory outcomes have been reported in up to 48% of cases, including malunion in 23%, avascular necrosis in 14%, and nonunion in 6% [6].

Surgical intervention for displaced fractures could result in better quality of life, avoiding the complications that frequently

* Corresponding author. Department of Orthopedics, Buddhist Tzu Chi General Hospital, 707, Section 3, Chung-Yang Road, Hualien, Taiwan. Tel.: +886 3 8561825x 2107; fax: +886 3 8577161.
E-mail address: ing.ho@msa.hinet.net (I.-H. Chen).

1016-3190/$ – see front matter
http://dx.doi.org/10.1016/j.tcmj.2012.08.010

develop after conservative treatment [6,7]. A randomized study demonstrated that higher Neer scores and better quality of reduction would be obtained after surgical treatment than closed reduction with sling immobilization in two-, three-, and four-part proximal humeral fractures [8]. The earlier the rehabilitation intervention after stable fixation, the more successful it is in achieving full range of motion under optimal selection criteria. However, postoperative complications such as hardware failure, bone failure, nonunion, and malunion often occur in patients with poor bone quality. Prior studies revealed that loss of reduction and intra-articular screw penetration occurred in up to 29% of proximal humeral fractures with initial anatomic reduction [9]. Gardner et al felt that medial cortical support is important in treating proximal humeral fractures; in their study, the average amount of humeral head collapse was 5.8 mm without this support [10]. Bjorkenheim et al demonstrated that 26% of proximal humeral fractures in patients treated with open reduction and internal fixation (ORIF) healed with a varus deformity after one year [11].

One method to enhance the outcome is the use of an intramedullary strut allograft. Chao et al stated that the fixation strength of different methods for fracture fixation is affected significantly by alteration of cortical and trabecular bone structures and material properties [12]. Generally, screws placed into cortical bone have better resistance to pullout than those placed into adjacent trabecular bone [13]. Intramedullary strut allografts have been widely applied in fracture treatments. However, there is a lack of large research studies on the effect of strut allografts in proximal humeral fractures.

The aim of the study was to review the results of proximal humeral fracture in elderly patients receiving ORIF, and to investigate if applying intramedullary strut allografts leads to better outcomes. We hypothesized that intramedullary strut allograft augmentation could provide stable fixation of fracture fragments and prevent humeral head varus collapse.

2. Material and methods

2.1. Patients

From January 2001 to March 2011, 116 patients, age 65 years and older, were admitted to Buddhist Tzu Chi General Hospital, Hualien, Taiwan because of displaced proximal humeral fracture and received ORIF. Their radiographs, charts and surgical records were reviewed. Patients were excluded if they had a Neer 2-part greater tuberosity fracture ($n = 3$), pathologic fracture ($n = 1$), lack of regular follow-up, incomplete surgical records, or any loss of radiographs ($n = 22$) during the follow-up period. In total, 90 patients were recruited into our study, and 55 patients among them were treated with intramedullary strut allografts. The use or nonuse of strut allografts was judged by operators based on bone quality, fracture nature, and comminutions. A strut allograft was often applied to assist fixation in complex proximal humeral fractures.

2.2. Operative procedure

Under general anesthesia, all patients were placed in a beach-chair position and a standard deltopectoral approach was applied. After deep dissection, the fracture site was exposed and reduced for fixation with a buttress plate and screws. If used, an intramedullary strut allograft with an optimal diameter and length was selected. It was inserted into the intramedullary canal distal to fracture site and then driven back to the proximal humeral bone (Fig. 1). Postoperatively, the arm was protected with a sling. Intramedullary strut allograft insertion was visible on postoperative radiographs.

The strut allografts, being part of radial shaft, ulnar shaft, humeral shaft, tibial shaft, fibular shaft, and femoral shaft, were taken from cadaveric donors. These strut allografts were stored in the freezer, at temperatures between −60 °C and −80 °C, until use. All allografts were free of blood-conducted diseases such as human immunodeficiency virus, hepatitis B virus, hepatitis C virus, and syphilis.

2.3. Radiologic analysis and outcome evaluation

The fracture type was defined as Neer 2-part, 3-part, or 4-part according to Neer classification on the preoperative radiography. Fracture union status was analyzed at 5 different time points: immediately and 1, 3, 6, and 12 months postoperative by checking shoulder internal and external rotation radiography (Fig. 1). Union was determined as appearance of bridging callus and disappearance of fracture lines on radiography. According to the United States Food and Drug Administration, a nonunion is considered to be established when a minimum of 9 months has elapsed since injury,

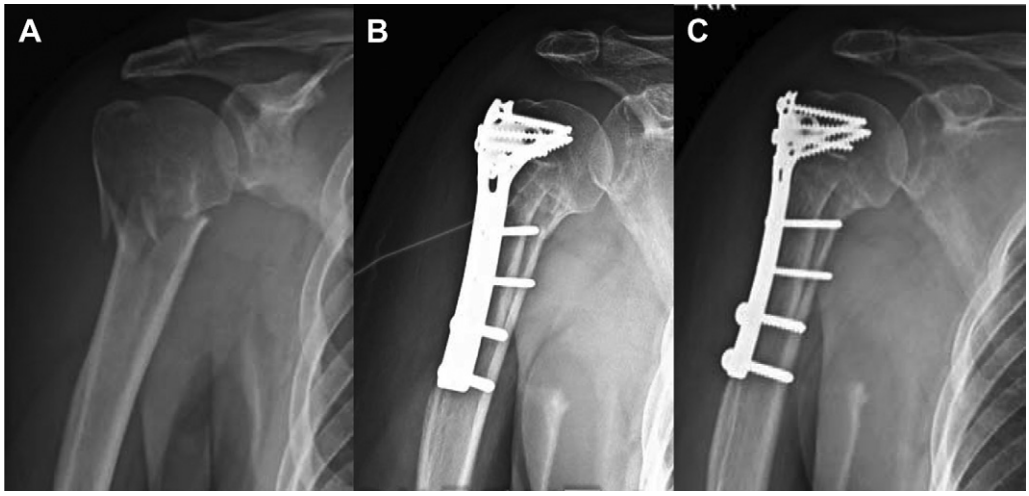

Fig. 1. A 69-year-old woman sustained a proximal humeral fracture after low energy trauma. (A) The radiographs demonstrate a Neer 3-part proximal humeral fracture. (B) Radiograph immediately after open reduction and internal fixation with a buttress plate and screws. An intramedullary strut allograft was applied. (C) The fracture status on the 6-month postoperative radiograph shows no loss of reduction and the intramedullary strut allograft is visible.