Injury, Int. J. Care Injured xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

# The results of tension band rotator cuff suture fixation of locked plating of displaced proximal humerus fractures

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ARTICLE INFO

*Article history:*
Accepted 26 December 2016

*Keywords:*
Proximal humerus fractures
Tension band suture
Shoulder functional outcome
Locked plating of proximal humerus fracture
Shoulder trauma

ABSTRACT

*Introduction:* The purpose of this study was to assess 1-year outcomes of patients with displaced proximal humerus fractures who underwent treatment with locked plate fixation with rotator cuff suture augmentation.

*Methods:* A total of 86 patients who had sustained 2, 3 and 4-part displaced proximal humerus fractures underwent locked plate fixation with multiple sutures placed in the cuff tendons. Clinical outcome variables included active forward elevation (AFE), active external rotation (AER), and Constant and American Shoulder and Elbow Surgeons (ASES) scores. Post-operative variables included the following complications: varus re-collapse, loss of fixation, osteonecrosis of the humeral head (AVN), screw cut out, hardware failure and infection.

*Results:* Forty-one patients were available with minimum of 1-year follow-up. Mean AFE was $142 \pm 17.0^{\circ}$ and AER was $41 \pm 13.0^{\circ}$. The overall complication rate was 14.6%, with osteonecrosis being the most common (12.2%). Of the 21 patients (51.2%) that initially had varus displacement, all but one maintained anatomic reduction and fixation. Mean ASES score was $78.2 \pm 20.0$ and average Constant score was $72.7 \pm 17.6$. Bivariate analyses demonstrated that pre-operative medial comminution ($p = 0.297$) or varus collapse ($p = 0.95$) were not associated with an increased likelihood of sustaining a complication.

*Conclusions:* Follow-up of patients in this series demonstrated a low overall complication rate and excellent functional outcomes. We believe suture augmentation of the rotator cuff can counteract varus forces on proximal humerus fractures fixed with locked plates, and should be performed routinely in displaced 2, 3 and 4 part fractures.



## Introduction

Proximal humerus fractures account for up to 4–5% of all fractures [1]. The incidence of proximal humerus fractures, particular in the osteoporotic elderly population continue to increase [2,3]. Though non-operative management is often reasonable for stable, minimally-displaced proximal humerus fractures [4–6], 15–20% of fractures are displaced and unstable [7], warranting operative management, as the outcomes of non-operative treatment can be unfavorable [8,9]. Several options for operative management of proximal humerus are available, including percutaneous fixation, open reduction internal fixation (ORIF), and arthroplasty [10,11], though the optimal treatment of these injuries remain controversial [12–19].

Locked plate fixation of comminuted 3-part and 4-part fractures has emerged as an established treatment modality, with increasingly encouraging results secondary to improvement in hardware and techniques [5,8,20–23]. However, complications such as intra-articular screw penetrance, osteonecrosis, malunion, and hardware failure continue to present barriers to achieving optimal results, with some series reporting complication rates of up to 66% [8,9,24–29].

The placement of tension band sutures within the rotator cuff has been recommended to counter the traction forces on the tuberosities, and has been shown to augment tuberosity reduction and improve overall fracture fixation [30,31]. We believe that this is a critical adjunct to locked plate fixation, particularly in cases of initial fracture varus angulation, which have been shown to be associated with worse outcomes and higher complications [25]. However, results of this technique are limited in the literature, and the effect of this technique on preventing varus re-collapse in

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http://dx.doi.org/10.1016/j.injury.2016.12.022
0020-1383/

fractures with initial varus angulation and medial comminution have not been the focus of a study, to our knowledge.

The purpose of the present study is to retrospectively assess the outcomes of patients who underwent locked plate fixation with rotator cuff suture augmentation for proximal humerus fractures, with particular attention to the technique's influence on preventing varus re-collapse or fixation failure in the presence of medial comminution. We also expected to observe a correlation between the complication rate and the presence of either medial comminution or initial varus fracture angulation.

## Methods

### *Patients*

After obtaining approval from our institution's Institutional Review Board, eighty-six consecutive patients with 2, 3 and 4-part displaced proximal humerus fractures who underwent locked plate fixation between September 2006 and April 2013 were identified. Forty-five patients were lost to follow up because of death, relocation or refusal to be included in the study. 41 patients remained with at least 1-year follow-up, and a mean follow-up period of 25.1 ± 13.3 months. Studies have demonstrated that outcomes after fixation of proximal humerus do not significantly change after 1 year [23,32]. All fractures in this study were classified according to the Neer classification [7].

Patients were excluded from the study if they were less than 18 years old, sustained polytrauma, had an open or pathologic fracture, underwent fracture management by means other than locked plating (i.e. percutaneous pinning or arthroplasty), or had follow-up of less than one year. All patients were treated by a by a single fellowship trained orthopaedic surgeon at our institution (B. O.P.)

### *Assessment and follow-up*

Preoperatively, standard four-view shoulder radiographs were obtained for all patients, with known critical variables having received particular attention (Fig. 1). Based on evidence from Hertel et al. [33], the medial calcar was examined with particular attention to the presence or absence of medial comminution. Additionally, the presence of initial fracture varus angulation was noted.

The medical records of all patients were reviewed by one of two authors. Fracture characterization was determined independently by two authors to ensure accuracy. All operative reports were reviewed for confirmation of specific details, including the performance of a biceps tenodesis and suture augmentation of the rotator cuff in all patients. The operative surgeon never used a structural allograft, nor did he ever use any bone void filler.

Clinical outcome variables were assessed at minimum regular follow-up intervals of 6 weeks, 3 months, 6 months, and one year, with some patients having followed up later than one year (range: 6 weeks–5 years). These included active forward elevation (AFE), active external rotation (AER), and presence of radiographic healing. At the final follow up visit of each patient, which was one year or longer, the physical examination and recording of AFE and AER were always performed by an author other than the operative surgeon (B.O.P.). Constant and American Shoulder and Elbow Surgeons (ASES) scores were collected in addition to routine clinical variables.

At each follow-up visit, physical examination was performed and standard 4-view shoulder radiographs were obtained to determine whether routine healing was occurring, or whether any complications had occurred. The complications of interest included varus re-collapse (in those patients with an initial varus fracture pattern), loss of fixation or hardware failure, intra-articular screw penetration, osteonecrosis of the humeral head, post-traumatic arthritis and infection. Varus re-collapse was defined as a neck-shaft angle $<120^\circ$ as measured on an anteroposterior (AP) radiograph with $20^\circ$ of external rotation.

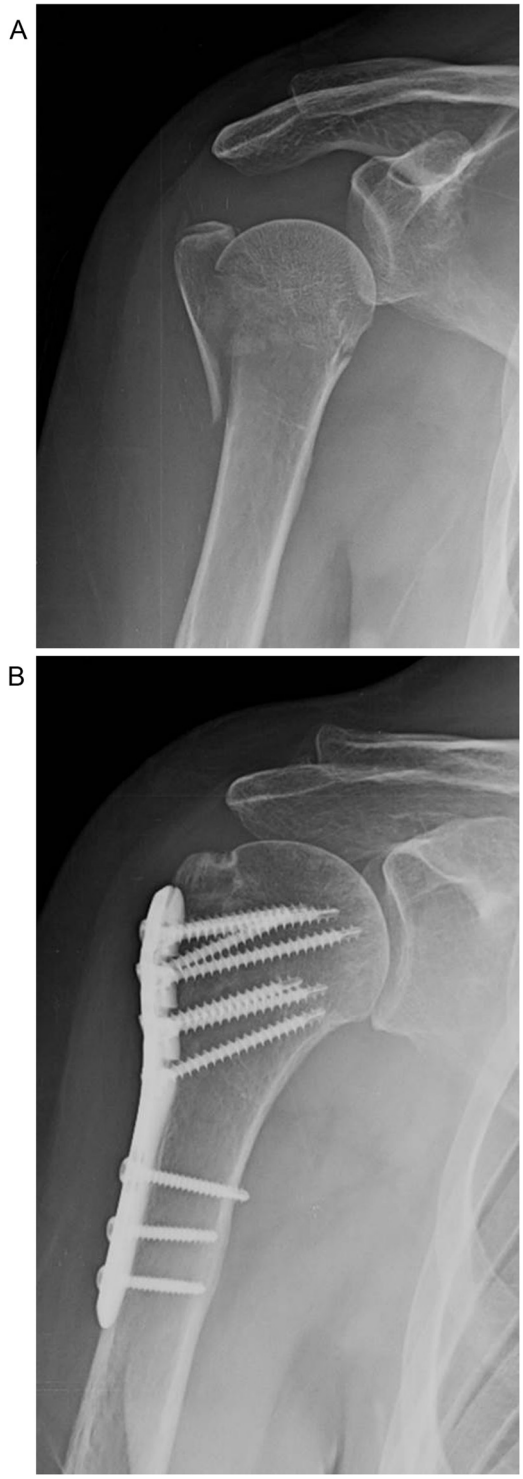


**Fig. 1.** Pre-operative (A) and post-operative (B) radiographs demonstrating a three-part proximal humerus fracture managed with locked plating.

Analysis of pre-operative patient characteristics to assess for association with occurrence of a complication was completed using Fisher's exact test for categorical variables or independent *t*-tests for continuous variables. $P < 0.05$ was considered significant

Please cite this article in press as: D.R. Shukla, et al., The results of tension band rotator cuff suture fixation of locked plating of displaced proximal humerus fractures, Injury (2017), http://dx.doi.org/10.1016/j.injury.2016.12.022