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## Radiographic and clinical results of tension suture fixation using two washers with PHILOS plate for proximal humeral fractures

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### ABSTRACT

**Introduction:** The purpose of this study was to evaluate the radiographic and clinical results of tension suture fixation using two washers with PHILOS plate (Synthes, West Chester, PA, USA) for proximal humeral fractures.

**Patients and methods:** Consecutive 39 patients were included and divided into two groups of adequate and inadequate medial support (MS (+) group vs MS (–) group). The mean follow-up period was 45 months (range: 26–69 months). The mean age at the time of surgery was 59 years (range: 17–86 years) and there were 12 men and 27 women. The clinical results were evaluated using the visual analogue scale (VAS) pain score, American Shoulder and Elbow Surgeons (ASES) score, and subjective shoulder value (SSV). The radiographic results were evaluated by serial radiographs and Paavolainen method, which measures the neck-shaft angle (NSA). We used the Paired T and Kruskal-Wallis test to compare radiographic and clinical results between the two groups.

**Results:** Bony union was achieved in 37 cases (94.9%). The mean NSA was changed from 133.5° postoperatively to 131.0° at the final follow-up period, but this change was not statistically significant. Thirty-five cases (89.8%) had good radiographic results as determined by the Paavolainen method. The mean final VAS pain score, ASES score, and SSV were 1.3, 87.3, and 86.0%, respectively. There were no significant differences between the two groups with respect to radiographic and clinical outcomes. Eight cases (20.5%) had complications including 5 with shoulder stiffness, 1 experiencing nonunion by fixation failure, 1 malunion, and 1 migration of greater tuberosity.

**Conclusion:** Tension suture fixation using two washers with PHILOS plate for proximal humeral fractures yielded satisfactory radiographic and clinical results. It can be a treatment option that can reduce varus deformity and fixation loss.

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### Introduction

Determining the most appropriate operative treatment for proximal humeral fractures continues to be challenging, especially on patients with osteoporosis. Although various techniques have been described (e.g., plate and screw fixation, intramedullary nailing, percutaneous pin fixation, tension band wiring, transosseous suture fixation, and arthroplasty), no consensus has been reached regarding the best treatment option [1–3]. With the advent of locking plate and screw, a greater number of displaced proximal humeral fractures are being treated with osteosynthesis [4–6]. Despite the increased use of locking plates, a loss of fixation

continues to be a problem with rates of collapse into a varus position ranging from 15 to 40% [7–9]. Because of its reported complications, several authors have emphasized the importance of maintaining soft tissues around the proximal humerus with respect to limiting displacement and maintaining stability [2,10–13]. To prevent these postoperative complications, several supplementary suture techniques using non-absorbable suture allowing for the incorporation of the rotator cuff as a fixation point have been described [2,11,12].

The purpose of this study was to evaluate the radiographic and clinical results of tension suture fixation using two washers with PHILOS plate (Synthes, West Chester, PA, USA) for proximal humeral fractures.

### Patients and methods

Approval for our institutional review board was obtained for this study. Between July 2009 and June 2012, 39 consecutive

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**Table 1**  
Demographic data.

	Total (n = 39)	MS (+) group (n = 30)	MS (–) group (n = 9)	p value
Age (years)	58.4 ± 15.4	59.6 ± 15.3	54.4 ± 15.7	p = 0.501
Sex (man: woman)	12:27	9:21	3:6	p = 0.849
Involved side (dominant: non-dominant)	24:15	20:10	4:5	p = 0.229
Injury mechanism (MVA/slip down/fall down/unknown)	18:16:3:2	12:13:3:2	6:3:0:0	p = 0.434
Interval from initial trauma to operation	4.9 ± 3.3	4.9 ± 3.0	4.7 ± 4.3	p = 0.588
Neer type (2-part/3-part/4-part)	14:22:3	14:15:1	0:7:2	<b>p = 0.004</b>
Follow-up (months)	44.9 ± 16.0	47.3 ± 14.6	36.9 ± 18.8	p = 0.299

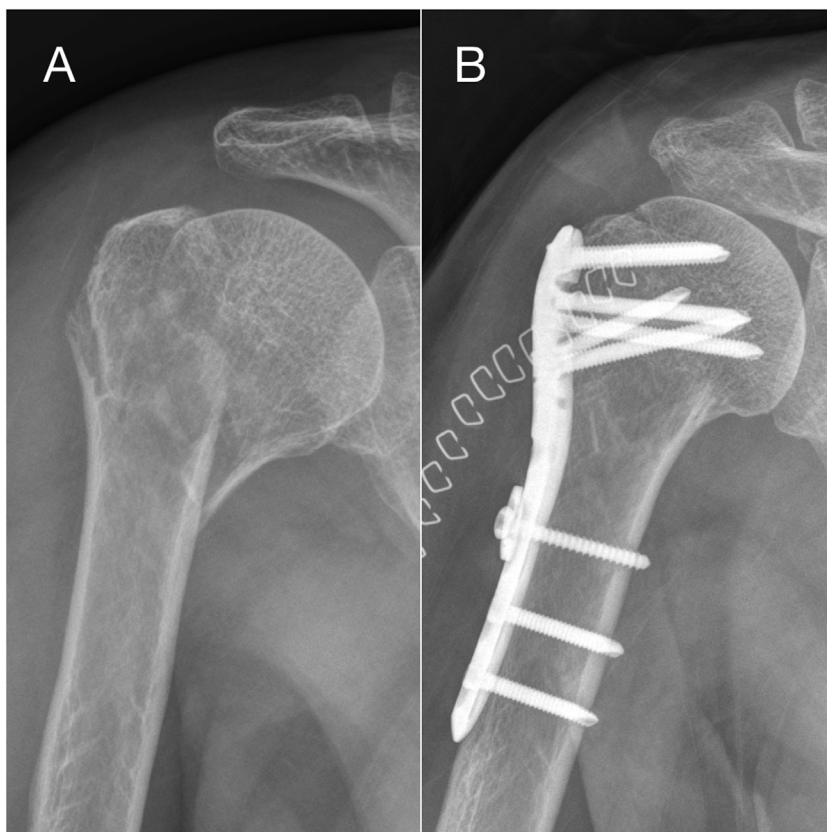
Statistically significant *p*-values are highlighted in bold values.

patients underwent tension suture fixations using two washers with PHILOS plate for proximal humeral fractures. Inclusion criteria included were 2-, 3-, or 4-part fractures according to the Neer classification [14], which were deemed to be unstable by the surgeon. Patients with pathologic fractures, an unreconstructable head, and/or tuberosity fragments, stable fractures without medial hinge disruption or metaphysical comminution, immature skeleton or less than 24 months of follow-up were excluded.

The mean age of all patients at the time of surgery was 59 years (range: 17–86 years) and 12 and 27 were male and female, respectively. The mean follow-up period was 45 months (range: 26–69 months). Fracture classifications are as follows: 2-part (14 cases), 3-part (22 cases), and 4-part (3 cases). All patients were then divided into 1 of 2 groups according to the presence or absence of medial mechanical support of the proximal fragment. The fracture was considered to have adequate medial support (MS (+) group; 30 cases) if: (1) the medial pillar of the proximal humerus was not comminuted and anatomically reduced; (2) the shaft was medialized and impacted into the head fragment; or (3) an oblique locking screw was placed directly into the inferomedial

quadrant of the proximal humeral head fragment to within 5 mm of the subchondral bone [15]. Conversely, fractures that did not fulfill one of these criteria were designated as having inadequate medial support (MS (–) group; 9 cases). No statistically significant differences were found between the two groups with regard to age, sex, involved side, injury mechanism, interval from initial trauma to operation, or follow-up period except fracture classification (Table 1).

Clinical results were evaluated using the visual analogue scale (VAS) pain score, American Shoulder and Elbow Surgeons (ASES) score, and subjective shoulder value (SSV). Range of motion was measured by active forward flexion, abduction, external rotation at side, and internal rotation at back values. And radiologic results were evaluated by serial radiographs and the Paavolainen method [16], which measures the humeral neck-shaft angle (NSA). The NSA was determined on the anteroposterior radiograph by drawing a line of the superior to inferior border of the articular surface and followed by a line perpendicular to it. It is formed into the intersection of a line bisecting the humeral shaft and this perpendicular line [16].



**Fig. 1.** Proximal humeral fracture treated as tension suture fixation using two washers with PHILOS plate is seen in (A) preoperative and (B) postoperative.

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