

# Contour Mismatch may lead to Malreduction

Amy Ravindra MD, Austin Roebke BS, Kanu Goyal MD

Department of Orthopaedic Surgery, The Ohio State University Wexner Medical Center, Columbus, OH



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## Introduction

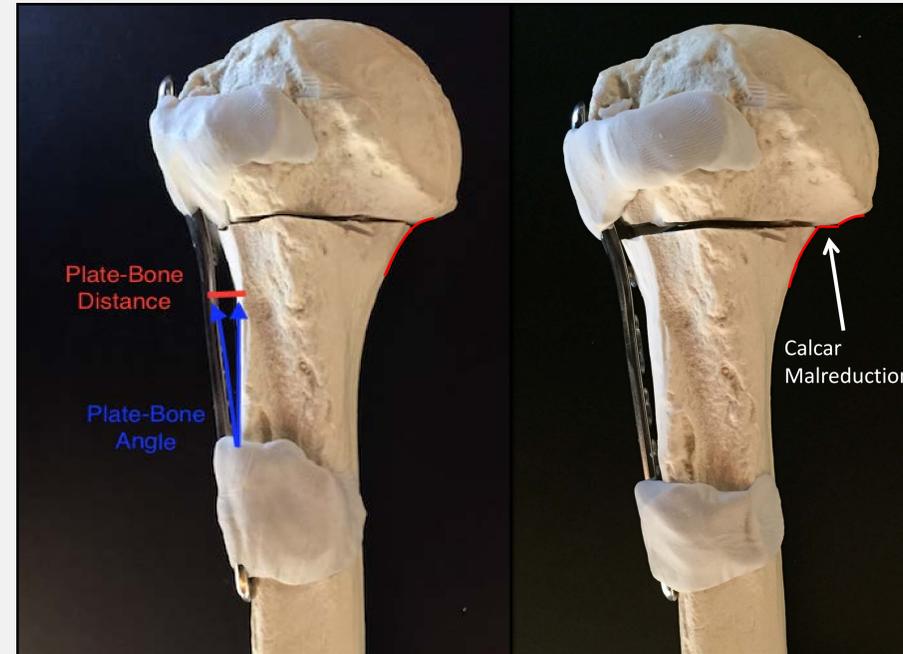
Mismatch between a proximal humerus locking plate and the lateral contour of the proximal humerus may have consequences for attaining and maintaining fracture reduction.

## Purpose

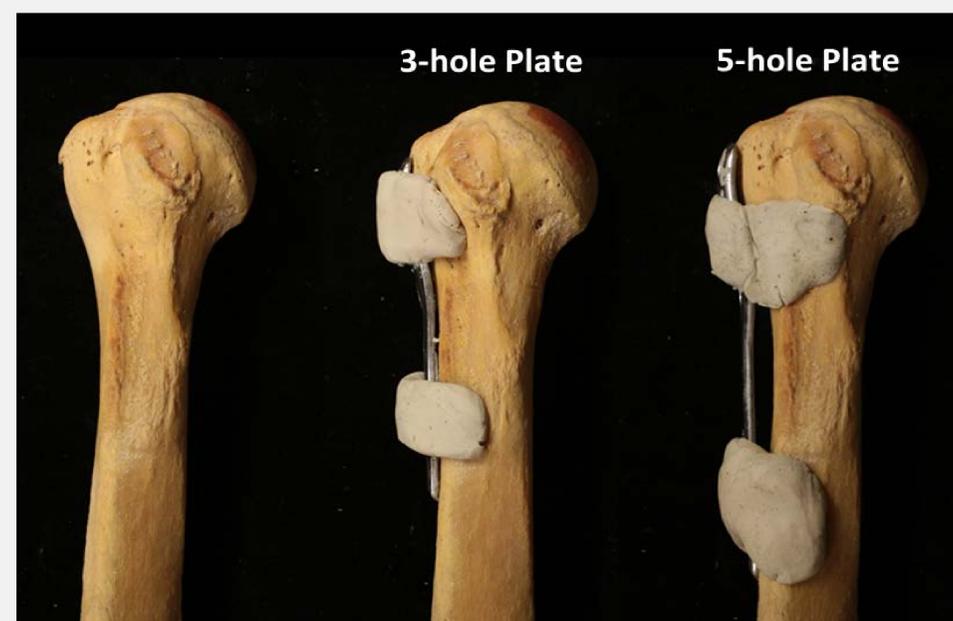
To investigate proximal humerus locking plate fit onto a large sample of human proximal humeri and to determine if there are any associated morphologic/demographic factors.

## Methods

97 cadaveric human humeri, evenly distributed by gender, race, age, and laterality were selected from the Hamann-Todd human osteological collection at the Cleveland Museum of Natural History. Humerus length, head diameter, and neck-shaft angle were measured. 3-hole and 5-hole 3.5 mm proximal humerus locking compression plates (Synthes, West Chester, PA) were affixed to the specimen with clay strips. If the plate was under-contoured and made contact with bone proximally and distally but not in the middle, the plate fit was described as “spanning”. A digital caliper was used to measure the maximum gap distance from the plate to the bone (figure 1). In the instance of a spanning fit, this was at the level of the proximal-most shaft screw hole. ANOVA and student’s t-tests were conducted to evaluate for differences in plate-bone distance between the two plate lengths, gender, race, age, and laterality. Correlation between plate-bone distance and humerus length, head diameter, and neck-shaft angle were determined using a simple linear regression.



**Figure 1:** Demonstration of fracture malreduction that may result from the plate being used as a reduction aide.



**Figure 2:** Plate-bone distance, and the capacity for malreduction, was greater with the 5-hole plate compared to the 3-hole plate.

## Results

The plate fit onto all 97 specimens (for both the 3-hole and 5-hole plates) were spanning. The mean plate-bone distance for the 3-hole plate was  $1.5 \pm 0.6$  mm (range 0.3 to 2.9mm), and for the 5-hole plate was  $2.5 \pm 0.9$  mm (range 0.7 to 5.0 mm) ( $p=0.01$ ). Female and right-sided humeri were shown to have significantly larger plate-bone gap distance when compared to their counterparts ( $p=0.01$ ). Age and race had no effect on plate-bone gap distance. No correlation was found between plate-bone gap distance and humeral length ( $R^2=0.03$ ), head diameter ( $R^2=0.05$ ), or neck-shaft angle ( $R^2=0.08$ ).

## Discussion and Conclusion

In this study, the proximal humerus locking plate was under-contoured and spanned all 97 specimens. A greater plate-bone distance was observed with the 5-hole plate versus the 3-hole plate (figure 2). Applying the plate flush to bone may lead to medial displacement of the humeral head at the calcar increasing the risk of loss of fracture fixation (figure 1). In fractures with any metaphyseal comminution, the malreduction will be more pronounced. Therefore, caution should be exercised when using the proximal humerus locking plate as a reduction aide. To avoid malreduction, alternative reduction techniques (figure 3) should be considered.



**Figure 3:** To avoid malreduction, first reduce the fracture and then apply the plate in a spanning manner.