Axial and Rotational Malreduction (Golf Club Deformity) in Distal Femur Fractures

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Background/Purpose: Open reduction and internal fixation of fracture have helped trauma patients to mobilize early for decades. The procedure helped in restoring the limb mechanics to close to their original state. Precontoured lateral condylar locking plates have been increasing in popularity as a method for stabilizing distal femur fractures since their development. They provided an edge to other methods by accounting for the natural contour of the distal femur. But despite their advantages, some studies have shown associated malunion rates between 11% and 26%. A specific problem in recent years have been described as a malreduction and medialization of the articular block, sometimes referred to as golf club deformity. The purpose of this study is to define the so-called "golf club deformity" and test a hypothesized solution. The authors hypothesize that the golf club deformity is a combined medial translation and axial external rotation which occurs when the plate is placed using current methods, and that placing the plate in a better anatomic position by placing it in 10° of external rotation, thus accounting for the normal slope of the lateral distal femoral condyle, should lower the malunion rates.

Methods: A supracondylar distal femur fracture model was created (AO/OTA 33A) using 7 fresh-frozen cadaver femurs. All femurs were radiographed prior to testing to ensure no previous fractures. An 8-hole, lateral distal locking femoral plate (Stryker) was placed flush to the lateral femoral condyle (Group I) and then reduced to the shaft (Fig. 1). In Group II, the anterior flange of the plate was externally rotated 10° in relation to the lateral condyle (Fig. 1). Optical motion capture (Max Pro optical tracking system, Innovision Systems) measured translation and rotation of the articular segment as screws were tightened and the plates were reduced to the femoral diaphysis. Since both configurations were applied to each bone, paired Student t test was used to compare the differences in measures of malreduction. The authors used a large database of 800 samples (Stryker Orthopedic Modeling and Analytics technology "SOMA") to confirm the anatomic alignment of the lateral femoral condyle.

Results: Average medial displacement of the articular block was 17.1 ± 10.4 mm vs 9.3 ± 4.7 mm for groups I and II, respectively (P = 0.02). Therefore, the average reduction in medial translation from group I to group II was 7.8 ± 6.8 mm. Plate external rotation in Group II improved medial translation by 46%. Average anterior displacement was 6.0 ± 4.3 mm vs 2.1 ± 1.2 mm for groups I and II, respectively (P = 0.08). Therefore, the average reduction of anterior translation was 3.9 ±4.9 mm and represented a 65% improvement in sagittal plane translation. Average external rotation was 12.2° ± 3.6° vs 2.5° ± 2.0° for groups I and II, respectively (P = 0.002). Therefore, the average reduction of axial external rotation was 9.7° ± 4.7°, representing an 80% improvement in axial malrotation. Looking at SOMA's database the authors found that the angle of the lateral distal femoral condyle has a mean posterior anterior inclination of 16.5° (Fig. 2).

Conclusion: Data presented here demonstrate significant medial translation (17 mm) and external rotation (12.2°) despite appropriate plate placement, as described in the literature. Placing the plate in 10° of external rotation was noted to largely, but not completely, correct the malalignment. Future studies will investigate other means of correcting the malalignment, especially considering the 16.5° posterior anterior inclination of the condyle.

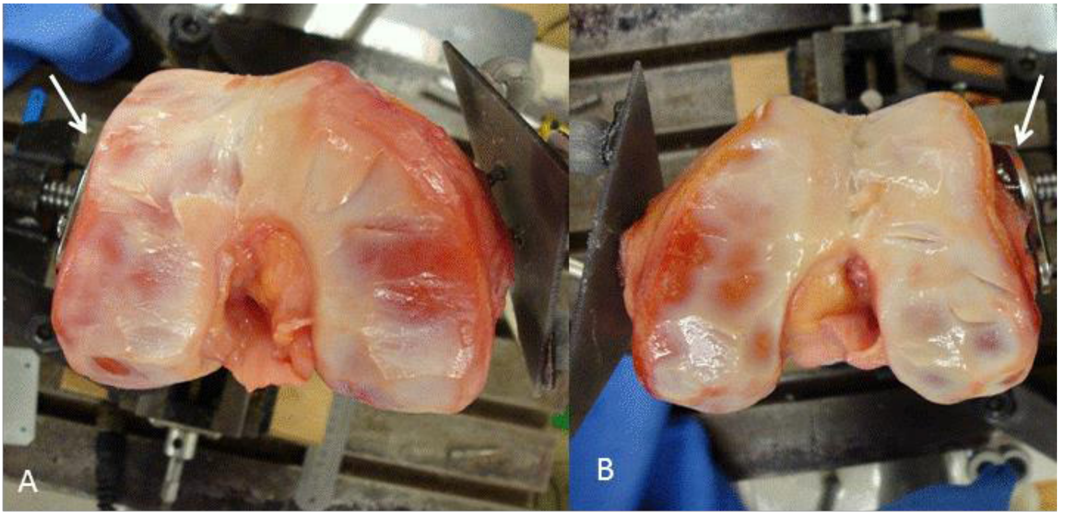

Figure 1: Photos of a speciemen from each group. A) Group I illustrates placement of the distal foot print flush to the lateral cortex (white arrow). B) Group II demonstrates external rotation of the distal foot print as indicated by the anterior flange sitting off the lateral cortex (white arrow).

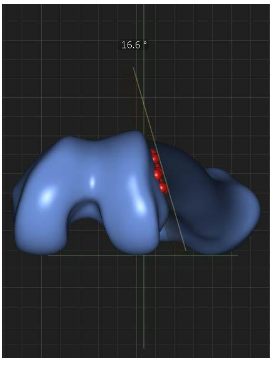

Figure 2: 3-D model showing the average degree of the distal femur inclination

See pages 47 - 108 for financial disclosure information.