Can Views of the Proximal Femur Be Reliably Used to Predict Malrotation After Femoral Nailing? A Cadaveric Validation Study

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Purpose: Malrotation after intramedullary nailing of femoral shaft fractures is a clinical problem that has been reported to occur in 15% to 40% of cases. One technique to evaluate rotation is to compare the amount of lesser trochanter that is visualized on standard AP hip film versus the amount visualized on the contralateral, uninjured side. Although this technique is commonly used, to our knowledge there are no data investigating its validity. The purpose of this study is to determine whether the amount of visualized lesser trochanter can be used as a surrogate for the degree of femoral rotation after fracture fixation. Our hypothesis is that this technique will be able to reliably detect clinically important differences in malrotation.

Methods: Twenty matched cadaveric femur pairs (n = 40) were obtained and mounted on a custom jig that allowed rotation along the axis of potential malrotation about a femoral nail. Sequential C-arm fluoroscopic images were taken of the proximal femur at 10° increments of internal and external rotation compared to a true AP of the hip as determined by knee position. The angle of rotation of the femur was measured with a computerized angular sensor affixed to the femoral shaft. The width of lesser trochanter visualized on each image was measured using standard PACS (picture archiving and communication system) clinical software and normalized to the maximum size observed to provide a percentage of trochanter observed for each image. The relationship between percentage of the lesser trochanter observed and angle of femoral rotation was analyzed using a trend line of the data.

Results: Rotation of the proximal femur demonstrates a consistent, linear relationship to the lesser trochanter ($r^2 = 0.87$). This linear relationship indicates that each 10% deviation in lesser trochanteric size corresponds to 7.7° of femoral rotation. The maximal size of the lesser trochanter was seen when the femur was externally rotated to an average of 34°, corresponding to the point when the intertrochanteric ridge begins to be visualized superior to the lesser trochanter. There was little variation in values between the left and right of each pair (paired *t*-test, $P > 0.1$) with the exception of one pair ($P = 0.02$), demonstrating that the contralateral hip is an excellent indicator of rotation.

Conclusion: To our knowledge, this is the first study to attempt to validate the common clinical practice of comparing the amount of lesser trochanter visualized on AP hip films to evaluate femoral rotation after intramedullary nailing. Our data demonstrate that the relationship between angular rotation of the femur and the size of the lesser trochanter is not only highly linear ($r^2 = 0.87$), but that the amount of change is quite sensitive to rotation. Previous authors have argued that clinically significant malrotation is thought to be somewhere in the 15° to 30° range, which corresponds to an easily measured change of 20% to 40% in size of the lesser trochanter. Clinicians can estimate the amount of malrotation using the relationship that roughly 8° of malrotation exists for every 10% difference in normalized size of the lesser trochanter.

See pages 99 - 147 for financial disclosure information.