Use of Inherent Anteversion of an Intramedullary Nail to Avoid Malrotation in Femur Fractures: A Prospective Study

Rahul Vaidya, MD[1]*; Radomir Dimovski, MA*[2]*; Zlatan Cizmic, BS*[2]*; Frederick Tonnos, DO*[3]*; Kerellos Nasr, MD*[1]*; Bryant Oliphant, MD*[1]
[1]*Detroit Medical Center/ Wayne State University, Detroit, Michigan, USA*
[2]*Detroit Receiving Hospital, Detroit, Michigan, USA;*
[3]*Detroit Medical Center/ Michigan State University, East Lansing, Michigan, USA*

Background/Purpose: Rotational malalignment after locked intramedullary (IM) nailing of femoral shaft fractures ranges from 19% to 56%. Differences greater than 15° lead to functional complaints. Several techniques have been suggested to avoid this problem especially in transverse or comminuted femoral shaft fractures. Espinoza et al have described a technique using the inherent anteversion of an IM nail to avoid malrotation in femur fractures (Espinoza Technique [ET]). The purpose of this study is to evaluate this technique in preventing malrotation in a prospective series of comminuted femoral shaft fractures.

Methods: A prospective IRB-approved study was performed from December 2012 to March 2016. 42 consecutive patients with comminuted (Winquist III and IV) femoral shaft fractures had locked IM nailing either with ET (19 patients) or our usual attempt at lining up proximal femur using the lesser trochanter and the patellar shadow over the distal femur. ET involved placement of second or third-generation femoral nails via "look back" lateral fluoroscopic views and superimposition of the drill and nail to bisect the femoral head. The distal locking screws were placed via a perfect circle fluoroscopic technique lining the perfect circle with a perfect lateral of the distal femoral condyles. Each patient had a CT scanogram conducted postoperatively to determine their femoral version for both lower limbs and leg lengths. Femoral version measurements were conducted using the Bonesetter application with axial cuts from CT scanograms. Version angles were measured with lines drawn along the axis of the femoral neck and the posterior aspect of femoral condyles. Outcome measurements included version of each femur, the difference in version, angle of each screw in comparison to the neck nail, as well as femur, tibia, and total leg lengths. Angles were also measured in second-generation IM nails from the central axis of the proximal locking screw and the two distal locking screws to assess what angle the nail actually produced. We also assessed our ability to center the proximal locking screws in the femoral head. Primary outcome of interest was a difference between operated and native femurs of >15° anteversion in the two operative groups, as a difference of this size results in notable asymmetry and complaint; null hypothesis was no difference between groups. Secondary outcomes included proportion of operated femurs with "normal" anteversion (8-15°), as well as a subgroup analysis of femoral anteversion agreement within 10° excluding those with abnormal native femoral anteversion (>15°). Given expectation of low cell counts, Fisher's exact test was the anticipated statistical test over X^2. All analyses were run as superiority (one-tailed) trials. Statistical analysis was performed using SAS 9.3 (SAS Institute).

Results: The average anteversion of the normal hips was 12.6 ± 7.1° (median 11.91°). The average anteversion using the ET was 9.9 ± 2.4° (range, 5.5-14.2°; median 10.53°). The average anteversion without this technique was 10.8 ± 8.3° (range, 1.1-35.4°; median 9.13°). In the ET

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

operative group, there was found to be 1/19 patients (5%) with a postoperative anteversion difference of >15° between native and operated limbs, as compared with 4/23 (17%) in the traditional approach group. The primary outcome of excessive difference between native and operated femoral anteversion between the traditional approaches and the ET group were found to be nonsignificant ($P = 0.24$). For secondary outcomes of interest, 14/19 (74%) in the Espinoza group exhibited operative anteversion between 8-15° ("normal"), versus 5/23 (22%) in the traditional approach group, a difference found to be statistically significant ($P = 0.0009$). Subgroup analysis of native leg versus operated leg differences excluding those patients with non-normal native leg anteversion resulted in the exclusion of 6 cases in the Espinoza group and 7 in the traditional group; this analysis demonstrated 0/13 cases >15° difference in the Espinoza group versus 5/16 (31%) in the traditional group, and was found to be statistically significant ($P = 0.037$). The average angle formed between the proximal and distal locking screws (we included first and second screws) was 9.4 ± 3.5° (range, 4.5-16.64°). We assessed our ability to center the proximal locking screws in the femoral head and found that we were on average 5.2 ± 5.0° off the center axis of the femoral head (range, 0-14.4°).

Conclusion: While the primary outcome of interest was found statistically nonsignificant, the increased incidence of clinically significant anteversion derangement was higher in the traditional group (17% vs 5%); the operative and risk burden on these patients potentially requiring revision is not discounted. Considering the Espinoza approach outperformed traditional approaches in terms of reliably creating 8-15° anteversion at a statistically significant level, the technique can be regarded as more reliable and consistent at creating a normal physiologic state. Subgroup analysis excluding those with native femur abnormalities also found superior performance in the Espinoza group (no large interfemoral anteversion derangements vs 33% in the traditional approaches group); this would suggest that it might be the preferred technique in those with normal native anatomy due to improved consistency of physiologic result. For those with native femural derangements, a modified Espinoza or traditional approach may be more appropriate. We found the ET better than our usual protocol for attempting to normalize the anteversion in comminuted femur fractures. It also takes less time. However, there are patients with inherent anteversions outside the norm and it is difficult to account for these using the ET. Technical aspects of this technique showed that there is some play in the locking mechanism of the second-generation nails we were using of about 5°, and our ability to place the proximal locking screw in the center of the head can vary approximately 5° as well. Although no technique is perfect, this one seems to improve our accuracy and variability and decrease the need for revision.

See pages 49 - 106 for financial disclosure information.