

Evaluation of Rotation Using Sagittal Fluoroscopic Images During Intramedullary Nailing of Femoral Shaft Fractures: Use of AI Software to Improve Its Accuracy

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Purpose: It is challenging to determine anatomic rotation during intramedullary (IM) nailing of femur shaft fractures. While clinical exams and fluoroscopic coronal imaging of the hip and knee have been used to estimate the femoral rotation, the high incidence of malalignment has been reported. We introduce a novel artificial intelligence (AI) software with sagittal fluoroscopic images to align the femoral rotation accurately during IM nailing.

Methods: Before the start of operation, a true neutral rotation (TNR) image of the distal femur is obtained on the uninjured side. Then, the C-arm is moved proximally to take the sagittal image of the proximal femur while the limb is stabilized and held in position with the C-arm at the same angle. After nail insertion and before the finalization of interlocking, a TNR image of the distal femur and the sagittal image of the proximal femur on the injured side is also obtained. Then, AI software is executed to eliminate the metal artifact, followed by its comparison between the injured and uninjured sides. When the adequate reduction is judged including the length, axis, and femoral rotation, the operation is finished. We verified the accuracy of the intraoperative imaging technique to get the correct rotational alignment, compared with the postoperative CT scan.

Results: 22 fractures (5 subtrochanteric fractures and 17 diaphyseal fractures) were included in this prospective study, fixed by IM nails (13 reconstruction nails and 9 standard nails). Measuring by the 3D CT scan, the mean value of anteversion was 17.4° in the uninjured femur (range, 5.2°~35.0°) and 14.7° in the operated femur (range, 2.5°~24.2°), respectively. The difference in femoral rotation between uninjured and operated femurs was 4.1° on average (range, -1.7°~13.5°). 20 of 22 cases showed a rotational difference below 10° (91%). There were 2 cases over 10°, but all were below 15°.

Conclusion: This study demonstrates the use of a novel intraoperative method to evaluate femoral rotation during IM nailing of femur fractures. This novel AI software with sagittal fluoroscopic images offers an accurate and reproducible way to reduce the rotational malalignment of femur fractures.