Saturday: Ankle Replacement: 12:21 – 12:23 pm

Implant Placement Accuracy and Patient-Specific Surgical Guide Reproducibility Using Pre-Operative Navigation in Total-Ankle Arthroplasty

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Summary:
Pre-operative navigation and patient-specific surgical guides were applied, for the first time, to total-ankle arthroplasty (TAA) in a cadaveric study. Reproducibility of each surgical guide placement and accuracy of the final implant position compared to the pre-operative plan were analyzed. Intra-observer guide placement varied less than 1.2° and final implant placement deviated less than 2° from the pre-operative plan. These preliminary data suggest that pre-operative navigation and patient-specific surgical guides result in reliable and reproducible placement of TAA implants.

Introduction:
Pre-operative navigation has provided many potential benefits for total-knee arthroplasty, including patient-specific alignment, repeatable implant placement, and decreased surgical time. For the first time, this advantageous technology was applied to total-ankle arthroplasty (TAA) and pre-operative capabilities at the ankle were explored. The current study determines intra-operator repeatability of tibia and talus patient-specific guide placement and the deviation between the pre-operative plan and actual implant placement.

Methods:
Routine ankle CT scans were acquired of three lower extremity limbs, converted into 3D solid models, and imported into a CAD assembly where anatomic landmarks defining tibia/talus alignment were established. The landmarks were used to perform a virtual TAA, where commercially-available implant components were placed to mimic traditional alignment. A surgical guide, referencing the cadaver-specific anatomy, was reverse engineered to accurately define the resection planes necessary to recreate the virtual placement of traditional tibia and talus implants in the post-operative position. Throughout the surgical procedure, the tibia and talus were tracked by a motion capture system. After a standard incision, board-certified, experienced TAA orthopaedic surgeons with no prior pre-operative navigation experience placed the surgical guides onto the bones in the best-fit location, based on tactile and visual feedback. Guide placement was repeated 4 times to determine variability. The surgical guides set the tibial/talus resection locations, inherently setting implant position. Final implant position was recorded with an infra-red probe, confirmed with CT scans, and compared to the pre-operative plan. Average deviations between planned and actual placement were determined for all rotational and translational degrees of freedom (DOF) set by the surgical guides (tibia: all DOF, talus: flexion/extension and varus/valgus rotation, and proximal/distal translation).

Results:
Average variation between implant pre-operative and post-operative placement was less than 2° and 1.4 mm in all specimens tested (Table 1). Intra-observer tibia and talus guide variation between all trials was 0.26°±0.18° and 0.36°±0.25° in flexion/extension, 0.61°±0.58° and 0.53°±0.53° in varus/valgus, and 0.79°±0.38° and 1.15°±0.77° in internal/external rotation.

Conclusion:
These preliminary data suggest that pre-operative navigation, along with custom surgical guides, results in both reliable and reproducible placement of TAA implants. Deviation of final implant placement from the pre-operative plan was less than 2° in all angular DOF, providing greater accuracy than the ± 3° determined in
other implant system studies using traditional instrumentation and computer navigation. Additional benefits of this novel technology include reduction of inter-operative fluoroscopy and surgical time, as well as patient-specific ankle alignment.

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<tr>
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<th>Tibia</th>
<th>Talus</th>
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<td></td>
<td>Degrees</td>
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<tr>
<td></td>
<td>Flexion/</td>
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<td></td>
<td>Extension</td>
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<td>Avg.</td>
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<td>-0.52</td>
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<tr>
<td>St. Dev</td>
<td>1.45</td>
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