A Tri-Plane Approach to Functional Positioning in Robotic Total Knee Arthroplasty

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This video describes a new technique for robotic total knee arthroplasty (TKA). The procedure may be confusing, and various techniques and approaches have been described. This technique involves a systematic approach, sequentially approaching implant positioning based on the coronal, transverse, and sagittal planes.

The coronal plane is approached first, and the goal is to achieve a cosmetic or straight knee. Patients expect a straight knee after TKA despite having had a knee that was in valgus or varus for much of their lives, especially after arthritis develops. With robotic TKA, the surgeon can, after developing the reference alignment system (this method involves a CT-based navigation approach), create a straight knee by visually assessing alignment and building in the cuts in the distal femur and the proximal tibia based on that alignment. In general, cuts are in 0° to 6° of mechanical varus; however, only the proximal tibia is cut first. The posterior femoral cut is made after determining the correct size and selecting a single size larger to preserve posterior femoral bone. This is done to facilitate increasing the femoral size if the flexion space is too loose and to facilitate rotational positioning of the femoral component to balance the medial and lateral flexion spaces.

The next step creates a consistent/systematic approach that makes robotic TKA reproducible despite the deformity and preoperative degree of disease. Flexion contractures and hyperextension can be managed objectively and transverse plane balancing can be performed. The posterior aspect of the knee is cleaned by removing the menisci and osteophytes and any loose bodies. Notch osteophytes are removed to ensure the posterior cruciate ligament is being tensioned appropriately. A mechanical distractor is then placed in the knee, and the knee is distracted in flexion and the desired terminal extension. A digital tensioner is part of the robotic software, and displacements and angular positioning can be modified within 0.5 mm and 0.5°, respectively. In addition, the insert size can be selected in the software and modified for balance. The technique is meant to create the soft-tissue sleeve that the final implant will experience through soft-tissue and osteophyte débridement and simulate the final implant through the mechanical distractor within the soft-tissue sleeve.

Balancing in the transverse plane is then completed via virtual implant positioning and usually is possible within 0.5 mm to 1.0 mm of displacement and 0.5° to 1.0° of angular positioning. The flexion spaces are compared with the extension spaces, and all four compartments are balanced accordingly. This balancing is performed by modifying the femoral implant position virtually with the use of software. The robot then makes the resections with a precision that creates the balance that was planned. Flexion contractures are managed objectively by moving the distal resection proximally if necessary, and hyperextension is managed by objectively moving the distal cut more distal.

The final step involves cleaning the debris after resection and placing the trials. Final assessment involves observing movement in the sagittal plane on the software screen, determining if rollback is attained, and visually confirming that the insert does not lift off. Slope can be added to the tibial cut if necessary.