Tactile-Guided Unicompartmental Knee Arthroplasty: Clinical Accuracy
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Introduction

Unicompartmental knee arthroplasty (UKA) can achieve excellent clinical and functional results for patients suffering from single-compartment osteoarthritis. However, UKA is considered to be more technically challenging to perform, and malalignment of the implant components has been shown significantly to contribute to UKA failures. It has been shown that surgical navigation and tactile robotics could be used to provide very accurate component placement when the bones were rigidly fixed in a stereotactic frame during preparation1. The purpose of this investigation was to determine the clinically realized accuracy of UKA component placement using surgical navigation and tactile-robotics when the bones are free to move.

Methods

Complete records, including pre-op CT, post-op CT, and surgical plan were available for 22 knees out of the first 45 procedures performed using a new tactile-guided robotic system (TGS™; MAKO Surgical Corp.). Three-dimensional component placement accuracy was assessed by comparing the pre-operative plan with the post-operative implant placement (desired versus actual). Utilizing 3D registration, the femoral component position was determined in the same coordinate system as the preoperative plan. Bone and implant models were obtained from postoperative CT scans taken immediately following the surgery using freely available segmentation software (ITK-Snap). A 3D to 3D iterative closest point registration procedure was performed with commercially licensed software (Geomagic Studio) and the measured implant position was directly compared to the preoperative plan. Errors were assessed as single axis root-mean-square (RMS) entities.

Results

Femoral component RMS placement errors averaged 1.4 mm/2.6º along any single axis. Tibial component RMS placement errors averaged 1.18 mm/2.14º along any single axis.

Figures 2 and 3 visually illustrate several representative samples of the implanted component positions (blue) relative to the preoperatively planned positions (grey).

Discussion

Using traditional manual instruments, Cobb et al. found average RMS errors of 2.20mm/5.48º. Using the robotic approach with bones fixed, Cobb et al. reported RMS errors of 1.11 mm/2.5º, directly comparable to our results with bones moving freely during surgery. Varus/vaLVus femoral component alignment and posterior tilt of the tibial component are within the accepted range to prevent excessive edge loading, leading to tibial plateau collapse and/or excessive wear. These results suggest excellent implant placement accuracy can be achieved using tactile robotics, and suggest excellent results are achieved in what typically would be considered a learning phase.

References