Robotic arm assistance for unicompartmental knee arthroplasty – a pilot study

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Introduction: Unicompartmental knee arthroplasty (UKA) has proven to be an effective treatment for degenerative joint disease confined to one tibiofemoral compartment.[1] However, poor UKA outcomes can occur due to incorrect alignment, improper implant rotation/sizing/position, excessive bony resection and component impingement.[2] Within the last decade, UKA performed with computer-assisted surgical navigation has resulted in more accurate and reproducible limb alignment.[3] Robotic-arm devices are a newer technology used for UKA that builds upon computer-assisted navigation. A cutting burr mounted on a passive robotic arm allows multiple degrees of movement during bone preparation, while the robot restricts the volume resected, thus ensuring fidelity to the pre-operative plan as determined using a CT-scan derived three-dimensional model of the joint [4]. This is intended to increase accuracy and reproducibility in the preparation of the femur and tibia for implant insertion. As a pilot study of robotic-arm technology, we have analyzed three-month functional outcome scores of a series of robotic-arm assisted medial UKAs and compared them to a comparable cohort of medial UKAs performed with conventional cutting jigs.

Methods: Sixty-one fixed bearing medial UKAs were analyzed for this study. The Columbia University Center for Hip and Knee Replacement (CHKR) database was used to locate all patients who underwent a medial UKA and completed both baseline and three-month post-operative Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) and Short Form-12 (SF-12) questionnaires. These criteria resulted in the selection of 30 robotic-arm assisted medial UKAs that were performed using the MAKO RIO system with Restoris implants. The selection criteria also produced 32 medial UKAs that were performed manually using the Zimmer Unicompartmental High-Flex Knee system and implants. All three participating surgeons are fellowship trained and certified in adult reconstructive surgery and have practices dedicated to adult reconstruction in the same medical center. Regression model analysis was performed by a dedicated statistician.

Results: The patients who underwent medial UKA via the conventional technique (CONV) saw higher gains from baseline in all sub-sections of the WOMAC score (larger numbers equate with improved outcomes) than did the robotic-arm assist patients (RAA) - pain score (37.2 CONV vs. 31.9 RAA), joint score (24.2 CONV vs. 13.0 RAA), function score (24.4 CONV vs. 20.1 RAA), and total knee score (29.8 CONV vs. 24.0 RAA). These trends held in the SF-12 mental component, where the conventional group saw greater gains than the robotic group (2.9 CONV vs. -0.9 RAA). The SF-12 physical component is the only area where the robotic-arm assist patients saw a greater increase than the manual patients (8.4 CONV vs. 12.2 RAA). However, when analyzed with regression analysis none of these inter-group differences were of statistical significance.

Discussion: These results are interesting as they demonstrate that the extra expense and operative time required for robotic-arm assisted UKA may not translate into immediate functional gains. This conclusion is limited due to the lack of significant follow-up time. Longer post-operative follow-up can provide more conclusive results. Furthermore, the study suffers from a lack of randomization - a well-designed randomized control trial could offer additional insight in the value of robotic-arm assistance.

References

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