Robotic-assisted Unicompartmental Knee Arthroplasty: The MAKO Experience

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KEYWORDS

• Unicompartmental knee arthroplasty • Robotic Assistance • MakoPlasty • Haptics

KEY POINTS

- This new robotic procedure provides comprehensive, 3-dimensional planning of partial knee components, including soft tissue balancing, followed by accurate resection of the femur and the tibia. This preparation allows for precise placement and alignment of the components.
- Patients have shown significant improvements in their postoperative function in every functional measurement, including more normal knee kinematics.
- The introduction of new procedures and technologies in medicine is routinely fraught with issues associated with learning curves and unknown potential complications.
- Because the specific objectives of this novel technology are to optimize surgical procedures to provide more safe and reliable outcomes, the favorable results seen to date prove this technology to be a significant improvement in the surgical technique of partial knee arthroplasty.

INTRODUCTION

In the late 1990s, Repicci and Eberle introduced a unicompartmental knee procedure using an inlay tibial component termed "minimally invasive surgery" (Fig. 1).[1–9] This procedure resulted in earlier mobilization, shorter inpatient stay, and shorter length of rehabilitation than had been observed for the conventional surgical approach. However, concerns were raised about loss of accuracy with minimally invasive techniques. With minimally invasive procedures, visualization is reduced leading to potential errors in implant placement, limb alignment, cement technique, and bone preparation (Fig. 2).[10,11]

The introduction of technology to improve accuracy of unicompartmental outcomes began with navigation. Jenny and colleagues[12] reported on a series of 60 patients who underwent navigated minimally invasive unicompartmental knee arthroplasty (UKA) and 60 patients who underwent navigated larger incision UKA. These authors cited

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Surgical Errors: Key Points to Consider

Surgical Errors are fully in the surgeons' control and have a prominent effect on implant survival. A surgeon must familiarize himself with the system of choice and perform a consistent amount of surgeries to achieve consistent outcomes. Unicompartmental Knee Replacement (UKR)s are very unforgiving to technical errors, which often lead to early postoperative failures.

Common Errors

- Overcorrection of alignment
- Flexion-extension instability
- Not achieving cortical rim coverage with the tibial tray/ or allowing overhang of components
- Patellar arthritis (grade 4) or instability
- Inset tibial poly tray may subside
- Poor cement technique
- Anterior placed femoral component

Poor visualization can lead to

- Over/under resection of tibia
- Over/undercorrection of limb alignment

Implant placement

- Tibia—under coverage of cortex, overhang
- Anterior Cruciate Ligament (ACL) injury
- Excessive slope
- Mal-rotation—internal rotation-external rotation (IR-ER) of implants
- Patellar impingement
- Cement retention
- Pin site fracture
- Retained osteophytes

the advantages of reduced surgical trauma, reliability, and safety obtained with the navigated minimally invasive procedure, whereas radiographic accuracy of implantation was the same for both minimally invasive and larger incision navigation techniques.

Justin Cobb first introduced robotic assistance in 2000 using the Acrobot robot to improve the accuracy of implant positioning during UKA.

Cobb and colleagues[13] first reported a prospective comparison of a tactile-guided robot-assisted UKA and conventional UKA performed with manual instrumentation. Their robotic system used static referencing that required rigid intraoperative fixation of the femur and tibia to a stereotactic frame. The primary outcome measurement was the angle of the tibiofemoral alignment in the coronal plane, measured by computed tomography (CT). Implant position errors relative to the planned position averaged 1.1 mm and 2.5° with robotic assistance compared with 2.2 mm and 5.5° conventionally along any axis. Overall tibiofemoral coronal plane alignment was within 2° for every case performed with robotic assistance. Only 40% of conventional surgery achieved this level of accuracy.

In 2006, MAKO Surgical Corporation obtained US Food and Drug Administration clearance to begin the first implantation of medial UKAs using a haptic-controlled passive robotic arm. This system allows an accurate surgical preparation of the