Robotically Assisted UKA is More Accurate than Manually Instrumented UKA

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Introduction:
The successful clinical outcomes following unicompartmental knee arthroplasty (UKA) depend on accurate component alignment, which can be difficult to achieve using manual instrumentation. A new technology has been developed using haptic robotics that replaces traditional UKA instrumentation. In addition to potentially improving accuracy, this technology utilizes a bone preserving inlay tibial design (as opposed to traditional onlay designs), which may result in reduced post-operative pain and quicker recovery due to preservation of the medial tibial plateau periphery and its densely innervated periosteum. This study compares the accuracy of UKA component placement and early clinical outcomes with traditional jig-based instrumentation versus robotic guidance.

Materials and Methods:
Seventy seven UKA patients from a single surgeon were included in this study. Forty-four standard onlay UKAs were performed using standard manual instrumentation were compared to 33 inlay UKAs performed with a robotically guided implantation system employing a haptic-guided burr for all bone resection. Each was performed using a minimally invasive surgical approach. The two groups were identical in terms of age (p=0.74), gender (p=0.65) and BMI (p=0.72).

The coronal and sagittal alignment of the tibial components were measured on pre- and post-operative AP and lateral radiographs. Postoperative tibial component alignment was compared to the pre-operative plan. A radiographic technique was developed to measure the depth of resection of tibial bone stock relative to the initial medial joint line. All patients received the same pain management and rehabilitation protocol and the length of hospital stay was measured. Knee society scores (KSS) were collected preoperatively and at three, six, and twelve week follow-ups. Marmor ratings were also determined for each follow-up.

Results:
For both techniques, the surgical objective was to match the natural tibial posterior slope. The RMS error of the tibial slope was 3.5° manually compared to 1.4° robotically. In addition, the variance using manual instruments was 2.8 times greater than the robotically guided implantations (p<0.0001). In the coronal plane, the goal of the manual technique was to implant the tibial component perpendicular to the anatomic tibial axis, while the robotic implantations attempted to match the natural varus of the medial compartment. The average error was 3.3 ± 1.8° more varus using manual instruments compared to 0.1 ± 2.4° when implanted robotically (p<0.0001).

Conclusions:
Tibial component alignment in UKA is significantly more accurate and less variable using robotic guidance compared to manual, jig-based instrumentation. This may significantly impact the choice of implant components (primary versus revision) should future conversion to TKA be necessary. Also, a significantly higher percentage of inlay patients are able to be treated as outpatients, possibly as a result of the less invasive (from a bone-preserving perspective) nature of this technique. Clinical results of this initial series of UKAs using a new haptic-guided surgical technique are comparable to those using established techniques, thus alleviating concerns regarding the acquisition of a new skill set and inferior outcomes at the beginning of the learning curve.

Figure 1. Robotic arm-assisted implantation system (left) and associated inlay UKA components with all polyethylene tibia (right).

Figure 2. Extramedullary alignment guide representative of standard manual instrumentation (left) and associated onlay UKA components with metal backed tibia (right).

Figure 3. Accurate posterior slope reconstruction accomplished with robotic guidance (left) compared with excessive posterior slope resection with manual instrumentation (right).

Figure 4. Accurate reconstruction of medial plateau varus resulting from robotic guidance (left) compared with valgus alignment of tibial component resulting from manual instrumentation (right).