MAKOplasty® and the RIO® Robotic Arm Interactive Orthopedic System

Background

An innovative approach for partial knee and total hip replacement procedures called MAKOplasty® uses robotic arm tactile technology to enhance accuracy and reproducibility in orthopedic surgery. The RIO® Robotic Arm Interactive Orthopedic System from MAKO is in a new class of surgical technologies known as human-interactive surgical robotic arm technology.

RIO System:

- RIO is comprised of a tactile robotic arm, a patient-specific visualization component and auditory feedback, that, when integrated with the touch and feel of the surgeon’s skilled hand, provides consistently reproducible precision for both partial knee resurfacing and total hip arthroplasty (total hip replacement) surgeries.
- The robotic arm’s tactile resistance is an important element of the RIO system that contributes to optimal alignment and positioning of implants during MAKOplasty procedures.
- The RIO system provides three-dimensional (3-D), high-definition visualization used for pre-operative and intra-operative planning, and is used during surgery to guide bone resection and implant insertion. This feature and the tactile robotic arm and other features of the RIO system all work together to enable surgeons to treat each patient uniquely.
- The tactile robotic arm responds fluidly to movements initiated by the surgeon operating the bone-cutting instrument during surgery.
- It is designed to achieve substantial dexterity and range of movement, and it helps enforce a tactile “safety zone” that is established by the patient-specific plan established before surgery.
- RIO provides tactile resistance when the boundaries of the tactile “safety zone” are reached, ensuring that surgeons do not move the bone-cutting instrument outside the intended area.
- While the robotic arm feels weightless when the surgeon is working within the safety zone, it instantly delivers the feeling of hitting a physical wall and stops when the surgical boundary is reached, preventing the surgeon from cutting bone outside the plan.

The RIO system from MAKO combines the best aspects of a computer based, patient-specific visualization and tracking system, with the “hands-on” tactile guidance and dexterity of the surgical robotic arm, in the field of orthopedic surgery.

MAKOplasty Partial Knee Resurfacing:

- MAKOplasty Partial Knee Resurfacing is a minimally invasive treatment option for people with early to mid-stage osteoarthritis that has not progressed to all three compartments of the knee. It can be performed as a unicompartamental procedure on any one of the three compartments of the knee (medial/inside, lateral/outside or patellofemoral/middle). It can also be performed as a bicompartamental procedure on the medial and patellofemoral portions of the knee.
• A computed tomography (CT) scan is taken of the patient’s knee. The RIO robotic arm system creates a 3-D anatomical model based on the patient’s own knee. This is used to develop a patient-specific plan for the optimal position of the implant based on the patient’s unique anatomy and helps the surgeon execute the plan with consistently reproducible precision.

• While resurfacing the diseased portion of the knee and preparing the bone for implants, the surgeon uses the robotic arm, which he or she is in control of at all times.

• The RIO system provides auditory, visual, and tactile guidance to prevent bone removal outside of the plan, and to assist the surgeon in accurately executing the patient-specific plan. It enables the surgeon to make intra-operative adjustments to the plan if needed.

• An implant is then secured in the joint to allow the knee to move smoothly again.

• Potential benefits of MAKOplasty Partial Knee Resurfacing over total knee replacement include: smaller incision, bone and ligament sparing, reduced blood loss, minimal hospitalization, more rapid recovery, less scarring, improved surgical outcomes, and less implant wear and loosening.

The use of the RIO system in MAKOplasty Partial Knee Resurfacing leads to implant placement that is two-to-three times more accurate than manual techniques\(^1\). Studies also show that patients with bicompartimental MAKOplasty have improved function over those with total knee replacement surgery, and that these MAKOplasty patients demonstrate better post-operative range of motion and quadriceps strength compared to total knee arthroplasty\(^2\).

A study recently presented by Roche et al. evaluated two year survivorship of robotic arm guided partial knee replacement in 201 patients (224 knees) receiving RESTORIS® MCK medial onlay implants from four different surgeons. Results indicated a very low revision rate of 0.4 percent at two years. This revision rate is more than nine times lower than that reported in registry data for manual procedures\(^3\).

MAKOplasty Total Hip Replacement:

• MAKOplasty Total Hip Replacement is a treatment option for adults suffering with either non-inflammatory or inflammatory degenerative joint disease who are in need of a total hip replacement.

• A CT scan of the patient’s hip is taken before surgery, and the RIO software is used to create a 3-D model of the patient’s unique anatomy. The surgeon can then plan the placement and alignment of the hip implants specifically for the patient’s unique anatomy before surgery.

• The surgeon-controlled robotic arm is used to prepare the bone in the acetabular socket of the pelvis for the implant. The surgeon holds and is in control of the robotic arm at all times while the RIO system provides auditory, visual, and tactile guidance to prevent the surgeon from removing bone outside of the surgical plan.

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• During surgery, the RIO provides real-time information and images that allow the surgeon to know and control accurate implant placement for both the acetabular socket in the pelvis and the femur.
• Potential benefits of MAKOplasty hip include: accurate placement and alignment of hip implants for each patient’s unique anatomy, and more consistency in leg length and hip offset. There is a reduced risk of impingement and dislocation.

In a recent oral presentation of a multi-center trial, Henrik Malchau, M.D., presented key results on the accuracy of robotic arm cup placement in 77 THA cases from four different surgeons. This study demonstrated that 84 percent of cups were positioned in an acceptable range4. This compares to data from a recently published Massachusetts General Hospital (MGH) study, which evaluated 1,823 hips receiving manual arthroplasty, which reported 47 percent of cups were placed in an acceptable range5.


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