

Robotic Assisted Knee Replacement Creating a Better Balance

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What is Arthritis?



Damage to the articular cartilage of a joint
Causes pain - inflammation-
loss of Function

Etiology of Knee Arthritis

- ❖ Elevated body weight
- ❖ Prior injury - ACL - Meniscus - Fracture
- ❖ Repetitive trauma
- ❖ Inflammatory conditions-Gout, RA
- ❖ Infection



ACL Injury

Without repair- 33% had arthritis by 14 yrs

McDaniel W.J et al *Clin Orthop Relat Res.* 1983;172:158-63

17-20 yrs post ACL injury

- Repair: 50% mild, 16 % severe OA
- No surgery: 50% mild, 50% severe OA

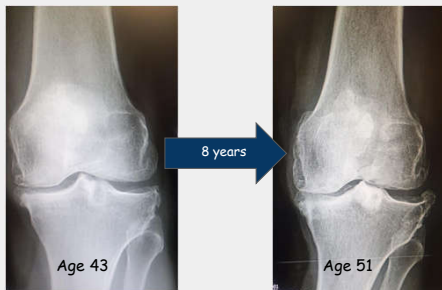
Mihelic R. et al *Int Orthop.* 2011;35:1093-7

Meniscus injury a risk factor for development of OA

Meunier A. et al *Scand J Med Sci Sports.* 2007;17:230-7.



ACL tear - Age 17 - Not Repaired

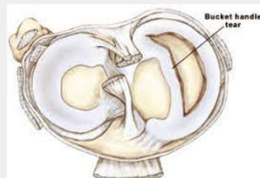


Meniscus Injury

Meniscus Root Tears - 10 years later

- Non Op: 95% OA, 45% TKA
- Resect: 99% OA, 51% TKA
- Repair: 43% OA, 33% TKA

Faucett SC et al. *Am J Sports Med.* 2019 Mar;47(3):762-769



Partial Medial Meniscectomy - 5 yr fu

Degenerative meniscus tear, no arthritis age 35-62

- Surgery vs Placebo : Slightly increased risk OA, mechanical sx at 5 yrs w surgery

Chitambar P, et al. *Br J Sports Med.* 2020;44(10):1111-1117

Treatment of Arthritis

- Physical Therapy
- Weight Management
- Corticosteroid Injection
- Viscosupplementation
- Dietary Modifications
- Bracing
- Surgery

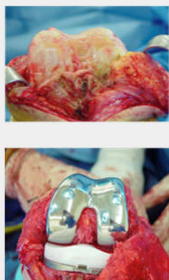


Total Knee Replacement

Improving Mobility & Quality of Life
Decreasing Pain

Total Knee Replacement

- ❖ 60-90 minute surgery
- ❖ Removes damaged cartilage
- ❖ Resurfaces knee with with a metal cap on tibia and femur
- ❖ Polyethylene liner
- ❖ Ligaments left intact



Recovery

- ❖ Same day discharge vs overnight stay
- ❖ Walker - Crutches x 2 wks
Cane x 4 wks
- ❖ 6 weeks Physical therapy
- ❖ Return to work:
Low demand job 4-6 wks
High demand by 8-12 wks



No Longer the Most Painful Procedure

- ❖ Better pain control
 - > Spinal
 - > Long lasting nerve blocks
 - > Decadron
- ❖ Less blood loss during/after
 - > Tranexemic acid
- ❖ Early mobilization = Less pain



Outcomes

- ❖ 85% extremely satisfied
- ❖ Most feel "stiff" x 1 year
- ❖ Many with difficulty kneeling
- ❖ Early revisions (<2 yrs)
 - > Infection
 - > Instability
 - > Stiffness

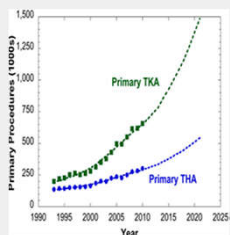


Robotic- Assisted Joint Replacement

Improving Alignment - Balance - Stability

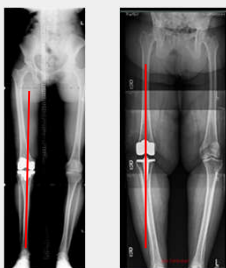
Why Are We Here?

- Ever growing number of total joint arthroplasties performed each year
- Estimated that 3.5 million TKA will be performed annually by 2030
- Numerous advancements with materials, operative techniques, implant design
- Despite these some patients are still unhappy with their TKA



Patient Satisfaction: Or Lack Of

- Successful operation ≠ Successful Outcome
- Surgeon satisfaction ≠ Patient Satisfaction
- 15-20% of patients report being "dissatisfied" or "very dissatisfied" with outcome
- Looks great...Feels bad



Why Aren't Patients Satisfied?

Symptoms

- Pain
- Swelling
- Instability
- Weakness
- Clicking/popping

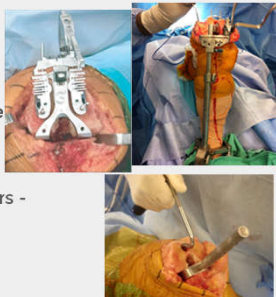


Surgical Factors

- Malalignment
- Instability
- Unbalanced gaps
- Implant positioning/sizing

Conventional Instrumentation

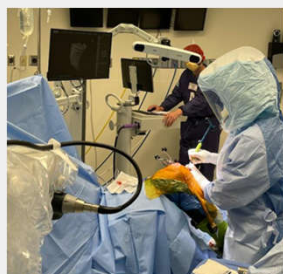
- Difficult to confirm targeted alignment
- Gap balancing also difficult to achieve
- Wide variability due to different instrumentation
 - Lamina spreaders - Gap tensioners -
 - Spacer blocks
- Anatomic deformity & Prior fractures



Why Robotics?

Match subjective assessment with objective data

- Reduces alignment outliers
- Balancing through ROM
- Fine tune adjustments = precision
- Less soft tissue and bone damage
- No intra-medullary instrumentation



What Can A Robot Do?

- Accurate/angular bone cuts, especially tibial cut
- Accurate tibial slope
- Avoid oversizing femoral component by accurately flexing component
- Reduce mid-flexion instability



But Its Not Just the Robot...

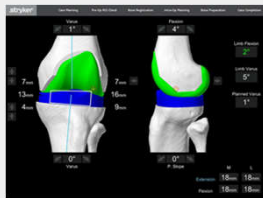
Not a substitute for knowing the fundamentals of how to balance the knee

- Must take into consideration the soft tissues - ligaments - osteophytes
- Must be able to recognize when the cuts do not make sense



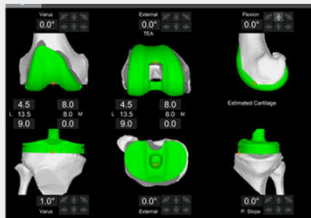
What does a Robotic Knee Achieve?

- The target overall limb alignment
- Accurate bone cuts (within 0.5mm and 1/2deg)
- Symmetric gap balancing
- Reduce need for soft tissue balancing
- Real time intraoperative information:
 - Limb alignment
 - Component sizing/position
 - Gap measurements: Flexion/extension, medial/lateral



How Does It Work?

- Pre-operative CT scan is obtained to evaluate bony landmarks
- Mako Product Specialist (MPS) & Surgeon establish pre-op plan
- Implant type, size, position
* all adjustable intraoperatively



Intraoperative Process

- Standard approach
- Pins/checkpoints/arrays
- Hip center/ankle/joint surface registration
- Gap assessment
Manipulation & Balancing
- Bone cuts



Balancing

- Multiple studies have shown balanced gaps lead to improved early outcomes
- Important to balance the knee
- Let the bone cuts do the work
- Fewer soft tissue releases



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Robotic-arm assisted total knee arthroplasty demonstrated greater component placement accuracy to plan compared to manual instrumentation: initial results of a prospective multi-center evaluation

Methodology

- Multi-surgeon, four centers and seven surgeons
- 144 robotic-arm assisted TKAs (RATKA) compared to 86 manual TKAs (MTKA)
- Groups had comparative demographics and preoperative disease state, function and health status

Results

- Improved precision and accuracy to plan of implant positioning for RATKA vs. MTKA
- Tibial alignment: RATKA ($1.3^\circ \pm 0.9^\circ$), MTKA ($2.3^\circ \pm 1.7^\circ$), ($p < 0.001$)
- Tibial slope: RATKA ($1.4^\circ \pm 1.1^\circ$), MTKA ($3.2^\circ \pm 2.9^\circ$), ($p < 0.001$)
- Femoral alignment: RATKA ($1.0^\circ \pm 0.9^\circ$), MTKA ($1.2^\circ \pm 1.0^\circ$), ($p = 0.137$)
- Femoral rotation alignment: RATKA ($1.1^\circ \pm 0.9^\circ$), MTKA ($1.9^\circ \pm 1.4^\circ$), ($p = 0.015$)

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Robotic-assisted total knee arthroplasty demonstrates decreased postoperative pain and opioid usage compared to conventional total knee arthroplasty

Methodology

- Prospective cohort study comparing 140 Mako Total Knee patients to 127 patients who underwent conventional manual TKA (MTKA)

Results

- At six weeks, the RATKA group required **3.2 mg less morphine equivalents** per day relative to the conventional group ($p < 0.001$), and a significantly greater number of patients in the RATKA group were **free of opioid use** compared to the conventional TKA group (70.7% vs. 57.0% ($p = 0.02$))
- Patients in the RATKA group had a **shorter LOS; 1.9 days versus 2.3 days** ($p < 0.001$)
- Patients in the RATKA group had a **greater percentage of patients discharged on postoperative day one; 41.3% vs 20.5%** ($p < 0.001$)

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Manipulation under anesthesia rates in technology assisted versus conventional-instrumentation total knee arthroplasty

Methodology

- 188 consecutive RATKA at 5 centers paired to 188 MTKAs
- All patients followed similar postoperative rehabilitation starting on postoperative day 1
- All patients were followed for minimum of 2 years

Results

- RATKA patients had a 4.5-fold decrease in MUA rate

| | RATKA (n=188) | MTKA (n=188) | p-value |
|--------------------|---------------|--------------|---------|
| Number of MUAs (%) | 2 (1.06) | 9 (4.79) | 0.032 |

Abbreviations: TKA=total knee arthroplasty, MUA=manipulation under anesthesia

RATKA patients had a 4.5-fold decrease in MUA rate.



**Lengths of stay and discharge dispositions after total knee arthroplasty:
A comparison of robotic-assisted and manual techniques**

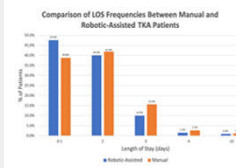
Methodology

5,993 MTKAs and 4,303 RATKAs performed between January 1, 2018, and March 31, 2019

- Lengths of stay, discharge dispositions, and Charlson Comorbidity Indices (CCIs) were recorded.

Results

- Mean LOS was lower in robotic-assisted (1.68 + 0.86 days) compared to manual (1.86 + 0.94 days) TKAs (p < 0.0001).
- 17 of the 24 included hospital sites (70.8%) had shorter LOS for robotic-assisted versus manual TKA
- A higher percentage of RATKAs 2,049 (47.6%) were discharged within one day compared to MTKA 2,325 (38.8%) (p < 0.0001).
- A higher proportion of RATKAs were discharged home (91.3%) compared to MTKA (87.4%) (p < 0.0001).



Final Thoughts

- ❖ Robotics Assisted TKA is a tool to improve outcomes
- ❖ Most benefit on severely deformed knees & prior fractures
- ❖ Most (but not all) are very satisfied after knee replacement
- ❖ Patient selection very important
- ❖ Total knee replacement can restore mobility and function

