Journal of Orthopaedics 15 (2018) 847–853

Contents lists available at ScienceDirect

Journal of Orthopaedics

journal homepage: www.elsevier.com/locate/jor

Patient reported and clinical outcomes of robotic-arm assisted unicondylar knee arthroplasty: Minimum two year follow-up

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ARTICLE INFO

Keywords:
Robotic assisted
Unicompartmental knee
MakoPlasty
Unicondylar knee arthroplasty

ABSTRACT

Background: Unicompartmental knee arthroplasty (UKA) originated in the 1950's. There have been many enhancements to the implants and the technique, improving the precision and accuracy of this challenging operation. Specifically for Robotic Arm Interactive Orthopedic System (Rio; Mako Stryker, Fort Lauderdale, FL), there are many studies reporting clinical outcomes, but our search offered nothing regarding patient reported outcomes using validated surveys.

Methods: Patients with onlay tibial components presenting for routine follow-up of robotic-arm assisted UKA performed between May 2009 and September 2013 were invited to participate. Four joints had simultaneous patella femoral resurfacing. Knee Injury and Osteoarthritis Outcomes Score (KOOS) and the 2011 Knee Society Scores were collected. Radiographic evidence of osteoarthritis in the non-operative knee compartments was documented.

Results: Eighty-one patients presented for follow-up and consented to participate. Mean follow up was 54 months. Mean patient reported KOOS activities of daily living and pain scores were each 90. Knee Society 2011 mean objective score was 96 and mean function score 81. There was one revision to total knee at 40 months post-op for pain after injury. Seventy-seven percent reported their knee always felt "Normal", 20% sometimes, and only 3% reported that it never felt normal.

Conclusion: Literature on UKA failure rates suggests that UKA may be a less forgiving procedure than total knee arthroplasty. Robotic-arm assisted surgery is reported to improve the accuracy of implant placement. Based on our prospectively collected positive patient outcomes, the authors have achieved good results from performing robotic-arm assisted UKA on select patients.

1. Introduction

The introduction of robotic-arm assisted technology for unicondylar knee arthroplasty (UKA) has revolutionized this challenging procedure. Prior to robotic technology, poor implant positioning was blamed for the high rate of revision in manual UKA procedures.[1–5] The robotic technology allows for precise component placement and ligament balancing that has improved clinical and radiographic outcomes in patients with isolated medial knee arthritis.[1–10]

What we do not have is data on how our patients feel about their knees two or more years after surgery. Is there pain? How well can you perform daily activities? Does it feel normal? With the shift toward patient-centered care, it is essential to focus on patient reported outcomes (PRO) as well as clinical results.

2. Materials and methods

One hundred and fifty-three patients underwent robotic-arm assisted UKA with a metal backed onlay tibial component between May 2009 and September 2013. Surgery was performed by authors DAC and TMS. Both surgeons had experience using robotic technology for nine months prior with each performing at least 18 robotic-arm assisted medial unicondylar knee arthroplasties with all-poly inlay tibial components. All patients presenting in clinic for routine follow-up at a minimum two-years after medial unicondylar knee arthroplasty with a metal backed onlay tibial component, were asked to participate in this

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https://doi.org/10.1016/j.jor.2018.08.018
Received 13 June 2018; Accepted 3 August 2018
Available online 16 August 2018

Institutional Review Board approved study. Patients that were not already scheduled received phone calls, letters, and emails reminding them that their annual follow-up was due. Eighty-four of the 153 possible study participants presented in clinic for routine follow-up. Eighty-one completed the informed consent process and were enrolled in the study. Sixty-nine of the possible participants did not come in for follow-up. Of those 69, 12 were deceased due to causes other than the knee. Twenty-one could not be located. Fifteen did not show up for their appointments and did not reschedule. The ten that returned phone calls said they were doing great, were happy with their knee and would come in only if they had a problem. Five had health issues other than their knee that prevented them from coming in. Five had no insurance and were not willing to pay for a visit but said they were having no issues with their knee. One subject was incarcerated in another state and one had been dismissed from the practice due to substance abuse. Sixteen subjects had bilateral procedures with four performed simultaneously. There were four knees in three patients that had simultaneous patellofemoral arthroplasty.

The Knee Injury and Osteoarthritis Outcome Score (KOOS) and the 2011 Knee Society Scoring System were administered using a combination of self-administration followed by live interview to ensure that no questions were missed[11,12] The 2011 Knee Society Score was chosen over the 1989 version due to the improved subjective patient reported component. The American Joint Replacement Registry was used as a data receptacle to calculate the scores. Routine annual clinical exam was performed and knee radiographs were obtained. Radiographs were assessed using the Kellgren-Lawrence Classification System to classify disease progression, if any, in the lateral compartment and the patellofemoral compartment in those patients without patellofemoral arthroplasty.[13] Pain levels specific to the lateral and patellofemoral compartments were also documented by the physician using a 0 to 10 pain scale with 0 being no pain and 10 being the worst pain. The physician questioned the subject regarding their pain unlike the 2011 Knee Society Score where the pain level was self-reported. Retrospective chart review was performed to collect history and physical findings as well as peri-operative data and length of stay.

Contraindications for UKA vary widely and during the time these surgeries were performed, highly debated.[14] Kozinn and Scott (1989) suggested exclusion of patients who weighed greater than 180 pounds, patients younger than age 60, patients who had more than minimal changes in the patellofemoral compartment, patients with anterior knee pain, patients with varus deformity greater than 10°, patients who were physically active or performed heavy labor, had a flexion contracture greater than 15°, inflammatory arthropathy, range of motion less than 90°, and anterior cruciate ligament deficiency.[15] This was considered the gold standard by many until Pandit et al. (2011) reported that these outdated contraindications for UKA could be ignored at least for mobile bearing UKA.[14] In our series of patients, we took the original gold standard contraindications into consideration but also looked at the individual patient regarding age, activity level, BMI, radiographic assessment, clinical exam, and expectations when making the decision to perform UKA versus TKA. The main reason for not explicitly adhering to the gold standard is that patients are individuals with different expectations and do not always fit into defined categories. As a result, seventy percent of the subjects in this study weighed more than 180 pounds and 38% were less than 60 years of age. More recently, Berend et al. (2015) reported a consensus statement from 6 surgeons with a combined experience of 8000 partial knees. The new gold standard for contraindications to UKA in general, is limited to systemic inflammatory arthropathy and previous high tibial osteotomy.[16]

2.1. Surgical technique

Stryker's Mako ™ robotic-arm assisted UKA was performed using the following surgical technique: The patient was taken to the operating room and placed in the supine position on the operating table. General anesthesia was then induced. The operative site was then prepped and draped in sterile fashion. A time out procedure was performed confirming operative site, preoperative antibiotics given, and equipment available. Percutaneous incisions were made over the femur and tibia and guide pins were placed using a power drill. Tracking devices for the robotic procedure were then attached to the guide pins. The limb was then taken through a range of motion to determine the hip center of rotation and points were taken of the medial and lateral ankle using the green probe. A longitudinal incision was then performed over the right medial knee from the superior patella to the medial proximal tibia and carried down through skin and subcutaneous tissue. A medial parapatellar arthrotomy was then made with a small extension into the vastus medialis obliqus. Checkpoints were then placed in the femur and tibia. Using a probe, the position of the checkpoints was confirmed. The femur was then registered, followed by the tibia. Osteophytes were then removed around the medial joint. The knee was then taken through a range of motion and applying a corrective force, these points were taken at varying degrees of motion. Next, slight adjustments were made to the preoperative plan to optimize tracking and stability. After confirming registration of the Mako System, the femoral resection was performed, followed by the tibial resection. Additional osteophytes were then removed. Trial components were placed and the knee was taken through a range of motion, comparing the position to the preoperative plan. After noting they were similar, the trials were removed. The checkpoints and guide pins were removed. The knee was irrigated with a pulsatile lavage containing polymyxin B 500,000 units, and the bony surfaces dried. The components were then cemented into place removing excess cement. A trial polyethylene insert was used and compression applied to the joint. After the cement cured, the trial polyethylene was removed and the joint checked for osteophytes and retained cement. The joint was irrigated again, and the definitive polyethylene was locked into place. After a final check of range of motion and stability, the tourniquet was deflated and hemostasis achieved. The capsule and percutaneous incisions were injected with a mixture of 40 ml 0.5% ropivacaine, Epinephrine 1:1000, 30 mg ketorolac, 10 mg morphine, and 80 ml 0.9% injectable NACL and the wounds closed in layers. A sterile dressing was applied. The irrigation solution and peri-articular injection components were considered appropriate at the time of the surgery but have changed since 2013.

2.2. Statistical analysis

Pearson's and Spearman's correlation coefficients were calculated to assess the link and the degree of relation between variables BMI, ASA scores, age, gender, and length of follow-up, with the KOOS, and Knee Society Scores. The correlation coefficient was considered very weak if smaller than 0.19, weak if 0.20 to 0.39, moderate from 0.40 to 0.59, strong from 0.60 to 0.79 and very strong if higher than 0.80. All statistical tests were considered significant at the 0.05 threshold. Implant survivorship was calculated and plotted using the Kaplan Meier Estimator.

3. Results/discussion

There were 47 (58%) females and 34 (42%) males. The mean age at surgery was 62 ± 10 (range 38–81) with a body mass index of 31.7 ± 4.8 (range 21.12–45.35). Mean length of symptoms prior to surgical intervention was 2.73 years (range 0.25–15 years). Mean follow-up was 54 months (range 24–85). Mean tourniquet time was 81 min (range 60–167) and the mean length of stay was 1.5 days (range 1.8–3.4). The American Society of Anesthesiology Classification (ASA) as determined by the anesthesiologist, was a 2 for 48% of the subjects, 46% were classified as a 3, and 6% were classified as a 4.

Radiographic assessment was performed at last follow-up on 80 subjects since one subject refused x-rays. The Kellgren–Lawrence Classification (Table 1) revealed no evidence of osteoarthritis (OA) in