Minimally Invasive Quadriceps-Sparing TKA: Results of a Comprehensive Pathway for Outpatient TKA

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INTRODUCTION

Until recently, total knee arthroplasty (TKA) has not been considered amenable to outpatient surgery given the substantial pain, impaired patient mobility, and concern over medical morbidities associated with this major surgery.[1] However, minimally invasive approaches to TKA have been developed to diminish morbidity and accelerate recovery while still achieving the original goals of the procedure.[4,10,17-19] Perhaps the application of these minimally invasive techniques to TKA[4,10,17-19] with new clinical pathways including improvements in anesthetic techniques, perioperative pain and nausea management, and rehabilitation protocols, will make performing outpatient TKA a possibility. The application of minimally invasive surgical techniques to unicompartmental knee arthroplasty combined with new rehabilitation protocols has allowed patients to be discharged the day of surgery and has resulted in accelerated recovery.[15]

To assess the feasibility and safety of outpatient TKA, a comprehensive perioperative management protocol was developed and implemented[1] based around a minimally invasive quadriceps-sparing TKA surgical technique,[17,18] regional anesthesia, and a comprehensive pathway. This protocol was applied to 100 consecutive patients in a prospective study. This article extends our initial report of 50 patients to our experience of outpatient TKA with these 100 consecutive patients.[1]

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MATERIALS AND METHODS

Between August 2003 and March 2005, one surgeon (R.A.B.) performed 394 primary TKAs. Of these 394 primary TKAs, 100 patients were enrolled in this prospective study. Patients were selected for enrollment in this outpatient TKA study based on defined inclusion criteria.[1] Patients undergoing primary TKA who had not undergone prior open knee surgery between the ages of 50 and 80 years qualified for enrollment; 313 patients met these criteria. Patients with a medical history within one year of myocardial infarction, pulmonary embolism, or on anticoagulation therapy were excluded. In addition, patients with significant obesity (body mass index [BMI] >40) or with $\geqslant 3$ significant medical comorbidities were excluded. A family support system was not necessary for inclusion in this study. Therefore, 264 patients met the inclusion criteria. Last, the protocol required the surgery to be completed as the first TKA of the day; this resulted in 100 patients enrolled out of 264 patients who met the enrollment criteria.

These 100 patients were followed prospectively for 3 months, assessing postoperative complications and the short-term outcome of their TKA. No patient was lost to follow-up. Patients were seen clinically at 1 week, 2 weeks, 6 weeks, and 3 months postoperatively. In addition, radiographs were taken immediately postoperatively, at 6 weeks, and at 3 months.[1]

Of the 100 patients enrolled in this study, there were 43 women and 57 men. Average patient age was 65 years (range: 50-80 years). Average weight was 194 pounds (range: 103-295 lb). The average BMI was 27.7 (range: 19.9-40). The preoperative diagnosis was osteoarthritis in 96 patients, osteonecrosis in 1, post-traumatic in 1, and rheumatoid arthritis in 2.

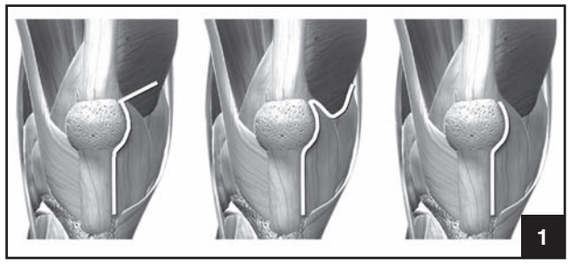

Figure 1. Mini-incision and minimally invasive approaches to the knee. From left to right: mini-midvastus, mini-subvastus, and quadriceps-sparing approach.

All 100 patients were enrolled in a comprehensive clinical pathway that included preoperative, intraoperative, and postoperative care.[1] This pathway combined efforts from the surgical team, anesthesia, nurses, physical therapy, occupational therapy, and discharge planners. At each step, critical points that could delay the patient's discharge were identified and addressed. This included tangible problems such as hypotension, nausea, pain control, and ambulation. In addition, we identified and addressed patient's apprehensions about same-day discharge, fears of increased pain, increased complications, delayed recovery, or dependence on others.

Preoperatively, all 100 patients attend a class taught by a nurse and a physical therapist, in which the expected hospital course and postoperative care were delineated.[1] We reassured patients that their pain would be adaquately controlled, they would be carefully monitored for the occurrence of complications or delayed recovery due to early discharge, and they would be able to ambulate independently after surgery. As part of the class, a physical therapist instructed the patients in gait training with weight bearing as tolerated, and an internist evaluated patients. Last, the hospital discharge planner called the patient at home prior to surgery to ensure that appropriate arrangements for discharge had been made such as transportation and home needs.

On the morning of surgery, 40 mg of valdecoxib (no longer used secondary to withdrawal from the market by the Food and Drug Administration) or 400 mg of celecoxib and 10 mg of oxycodone hydrochloride controlled release was administered orally. An epidural anesthetic without narcotic additives was attempted in all cases. Placement of the epidural catheter failed in three patients whereby general anesthesia was administered. Both intravenous (IV) and epidural narcotics were avoided. Propofol, a short acting sedative, was titrated during the procedure for sedation. Four mg of ondansetron hydrochloride and 10 mg of metoclopramide were administered through an IV during the case to decrease nausea.[1] Patients also were kept well hydrated to prevent postoperative hypotension and nausea. In all patients, a foley catheter was inserted and prophylactic IV antibiotics were administered prior to the skin incision.

A minimally invasive TKA technique is used whereby the quadriceps muscle and quadriceps tendon is not violated (Figure 1).[17,18] Only a capsular incision was made below the superior of the patella. The knee is not dislocated; instead, in situ cuts are made. A cruciate retaining total knee (NexGen, Zimmer, Warsaw, Ind) was used in all patients (Figure 2). A re-transfusion drain was used in all patients.

In the recovery room, a second dose of ondansetron hydrochloride was administered. The epidural (fentanyl 10 (g/mL+.1% bupivacaine) at 6 cc, 1 cc every 15 minutes with 40 cc for 4-hour lockout, was continued in the recovery room.

Two hours postoperatively, the foley catheter was discontinued and 20 mg of oxycodone hydrochloride controlled release was given orally. Four hours postoperatively, the epidural was removed and the re-transfusion drainage was re-infused. Subsequently, the IV tubing was removed and the IV catheter was maintained with a heparin lock just prior to physical therapy. Physical therapy was completed five to six hours postoperatively. The patients were weight bearing as tolerated. One additional dose of IV antibiotics was given after physical therapy and then no additional antibiotics were given.

Discharge was permitted when strict criteria were met.[1] As a hospital requirement, all patients must complete a formal physical therapy protocol. This protocol requires that patients can independently: transfer out of bed to standing and into bed from standing, rise from a chair to standing and sit from standing, ambulate 100 feet, and ascend and descend a full flight of stairs. The patient must exhibit stable vital signs, tolerate a regular diet, and have adequate pain control from oral analgesics. Only after all of these criteria are met is the final criteria invoked–does the patient feel comfortable going home and want to be discharged? When ready, all patients are discharged from the hospital, not to other care facilities.

Upon discharge, patients continued taking Cox-II inhibitors for at least two weeks and gradually decreased their dose of oxycodone hydrochloride controlled release as needed; hydrocodone was taken as needed for breakthrough pain. All patients received acetaminophen for deep venous thrombosis prophylaxis for three weeks. Patients were encouraged to start activities as tolerated. They were allowed to drive when off all narcotics. Home physical therapy is used until the patient can drive and then outpatient physical therapy is started. Patients were evaluated clinically and radiographically in the office at 1 week, 2 weeks, 6 weeks, and 3 months.

RESULTS

All 100 patients successfully completed this study. Ninety-seven patients had an epidural anesthetic, 3 had general anesthesia due to inability to successfully enter the epidural space. The mean surgical time was 104 minutes (range: 74-136 minutes). The mean tourniquet time was 109 minutes (range: 82-139 minutes). The mean incision length was 8.9 cm (range: 6-11.2 cm).

Postoperatively, 24 patients required additional treatment for nausea and hypotension. This treatment included additional ondansetron hydrochloride and increased IV fluids. In 23 patients, these symptoms resolved without significant delay in the pathway for discharge. Of the three patients who had general anesthesia, one patient developed orthostatic hypotension that resolved the evening of surgery; however, he had continued nausea until the next afternoon.

Of the 100 patients enrolled in this prospective study, 98 (98%) were discharged the same day. Ninety-nine patients successfully met all the discharge criteria the afternoon of surgery. Of the 99 patients, 1 chose to stay overnight and was discharged the following morning. One patient did not participate in the afternoon physical therapy session due to orthostatic hypotension and nausea as noted above. This patient met all the discharge criteria by the following morning, but due to continued nausea stayed another day.

All patients were discharged to home on oral medications only. No IV medications, epidural infusions, nerve catheter infusion, or local infusion systems were used. There were no cases of urinary retention despite the brief use of a foley catheter.

Ninety-one (91%) patients were discharged to home with either a cane or no assist device, 8 (8%) were discharged to home with crutches, and 1 (1%) was discharged with a walker.

Home physical therapy was initiated in 83 (83%) patients, while 17 (17%) patients immediately started outpatient physical therapy. Within 1 week, 74 (74%) patients started outpatient therapy and by 2 weeks all 100 patients had begun outpatient therapy. The average range of motion was 112° (range: 75°-132°) by one week

After discharge, 1 patient was readmitted for a bleeding ulcer at 8 days postoperatively with subsequent resolution. Another patient with a history of coronary artery disease underwent a cardiac angioplasty for ischemia at 2 weeks after discharge without complication.

One patient underwent a superficial irrigation and debridement for a subcutaneous infection at 21 days postoperatively. The wound subsequently healed without incident.

Two patients, who had poor flexion preoperatively, failed to make adequate progression in range of motion and underwent manipulation. One had 90° of flexion prior to a closed manipulation with improvement to 125° at 3 months. The other had 75° of flexion prior to a closed manipulation with improvement to 115° at 3 months.

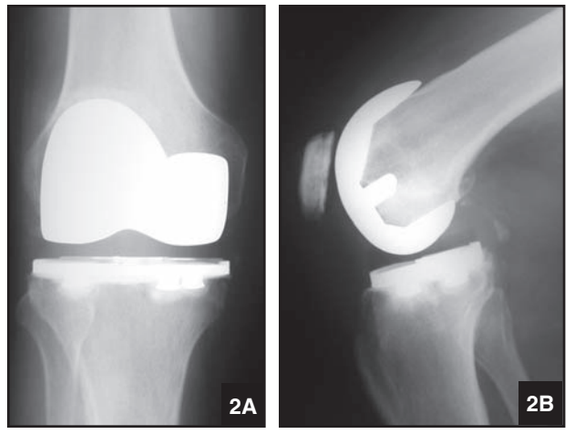

Figure 2. AP (A) and lateral (B) radiographs of a minimally invasive TKA with a cruciate retaining prosthesis with the four-peg tibia.

DISCUSSION

The purpose of this prospective study was to evaluate our initial experience of attempting outpatient TKA using a quadriceps-sparing surgical technique and a comprehensive clinical pathway on 100 patients, thereby extending our initial report of 50 patients.[1] Of the 100 patients in this prospective study, 98% were discharged the day of surgery. This study shows that outpatient TKA is feasible. Furthermore, there were no readmissions, reoperations, or significant complications related to early discharge in this patients group, demonstrating that outpatient TKA is safe.

This study has shown that early discharge does not result in acute readmissions or other post-discharge complications related to early discharge. Other authors also have shown that a decreased length of stay does not increase complications after total joint replacement.[3,9,11,13] More specifically, other authors have shown that minimally invasive total joint arthroplasty is safe and associated with accelerated recovery. Romanowski and Repicci[15] demonstrated shorter length of stay, less pain, and quicker recovery without increased complications with minimally invasive unicompartmental knee arthroplasty. This has been found in other orthopedic knee procedures that have moved to outpatient procedures, such as arthroscopic meniscotomy[5,6] and anterior cruciate ligament reconstruction.[2,16]

Of the 100 patients enrolled in this study, 98% were discharged the day of surgery. We believe that the combination of this comprehensive pathway and the minimally invasive surgical technique are critical to achieving out-

patient TKA.[1] Many authors have cited the implementation of specialized clinical pathways with decreasing the length of stay in total joint replacement.[7-9,11,12,14] The high rate of discharge to home the day of surgery in this study was in part due to our team's responsiveness to early signs of nausea and hypotension that on which were swiftly acted. In fact, 24 of the 100 patients required additional treatment for nausea and hypotension. This treatment included additional ondansetron hydrochloride and increased intravenous fluids. In 23 of 24 patients, these symptoms resolved without significant delay in the pathway for discharge.

We found that addressing and alleviating the patients apprehension about outpatient TKA is what our comprehensive pathway facilitated. In general, these apprehensions include having pain, developing a complication, having a slower recovery, and being dependent on someone else. Once these fears were dispelled, most patients preferred to be discharged to recover at home rather than stay in the hospital.

Most patients usually are independent preoperatively, even with the pain and disability of their arthritic knee. Therefore, when the TKA results in minimal postoperative pain and anesthesia side effects, they are independent enough to be discharged to home immediately.

Last, this study also demonstrated that combining a minimally invasive TKA approach and preemptive analgesia, the patient's postoperative pain was adaquately controlled, resulted in no patient having to stay overnight due to pain.

We have shown that outpatient TKA using a minimally invasive approach with a comprehensive pathway can be done safely in selected patients. We have further refined this technique and pathways and are currently performing outpatient total joint replacement daily.

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