Comparison of 2 Polyethylene Inserts for a New Cruciate-retaining Total Knee Arthroplasty Prosthesis

Michael A. Mont, MD; Christopher R. Costa, MD; Qais Naziri, MD; Aaron J. Johnson, MD

Abstract: Cruciate-retaining total knee arthroplasty has had high success rates but does not always have optimal functional outcomes. The purpose of this study was to compare 2 polyethylene inserts of varying constraint that were used in a new cruciate-retaining total knee arthroplasty design to determine whether differences were found in clinical or functional outcomes. The use of the newer cruciate-retaining total knee arthroplasty design showed comparable results with both polyethylene inserts at short-term follow-up. The cruciate-retaining design had a greater than 99% survivorship, although further study is needed to make assessments regarding long-term functional results and outcomes.

Total knee arthroplasty (TKA) has had excellent long-term results, with several designs having greater than 90% survivorship at 10 to 20 years postoperatively.\(^1\)\(^6\) Because TKAs are being performed on younger and more active patients,\(^1\) manufacturers have attempted to improve the stability and durability of their designs and recreate kinematics that better approximate those seen in the native knee. Cruciate-retaining designs offer the potential advantage of preserving the posterior cruciate ligament (PCL), which in turn may aid knee kinematics and preserve proprioception during stair climbing, maintain femoral rollback during flexion, and increase the overall stability of the prosthesis.\(^7\)\(^10\)

Despite the excellent outcomes reported for cruciate-retaining designs, some authors question the above advantages and report conflicting results regarding anteroposterior laxity and decreased range of motion compared with posterior-stabilized TKA models.\(^10\)\(^11\) The Triathlon total knee system (Stryker Orthopaedics, Mahwah, New Jersey) is a cruciate-retaining implant design that has a single-radius, spherical rotary arc design to increase the rotation needed for deep knee flexion. A deeper anterior cutout in the tibial polyethylene insert also allows for deep flexion and decreased patellar tendon stresses. These designs were made in an attempt to recreate natural knee kinematics without losing stability and to maximize range of motion. The overall goal of these changes was to create a TKA that had a more natural feel to the patient, increased range of motion, and maintained stability.

This new design has 2 tibial polyethylene inserts available. Compared with the standard cruciate-retaining insert, the more constrained cruciate-substituting insert has a raised lip that provides greater anterior constraint and a recess to allow for stability in hyperextension. The purpose of the current study was to directly compare the 2 inserts in this new cruciate-retaining TKA design. Pain and functional Knee Society scores (KSS), adverse events, survivorship, and radiographic outcomes were compared between the groups at a 2-year minimum follow-up. This study received institutional review board approval.

Materials and Methods

Between 2005 and 2009, thirty-two TKAs were performed using a Triathlon total knee system cruciate-retaining design along with a constrained CS polyethylene insert. The cohort included 17...
women (18 knees) and 12 men (14 knees) with a mean age of 62 years (range, 37-88 years) and a mean body mass index of 31 kg/m².

During this same time period, 139 TKAs were performed in 124 patients using the same implant system but with the cruciate-retaining tibial bearing insert, which provides less constraint than the CS insert. The second cohort included 77 women (87 knees) and 47 men (52 knees) with a mean age of 60 years (range, 31-83 years) and a mean body mass index of 32 kg/m². One patient had a periprosthetic fracture that required a closed reduction 3 months after the initial procedure. Revision of the components was not necessary in this patient, and at 36-month follow-up the patient reported no complaints of pain and had no clinical or radiographic signs of loosening. This patient was excluded.

All patients in both cohorts received a cruciate-retaining prosthesis and therefore had an intact PCL at surgery. No PCL releases were performed. The analysis of the results of these patient cohorts was approved by the appropriate institutional review board.

Preoperatively, patients were evaluated in the clinic. Details of their knee symptoms, medical history, and demographic information were tabulated. Unless contraindicated, all patients received spinal anesthesia. A medial parapatellar approach was used to gain exposure to the knee. All patients had a trial fit with a cruciate-retaining knee insert. Patients who required more substantial constraint to improve fit or were deemed to be at risk for potential postoperative instability had a more constrained CS insert implanted at surgery. Reasons for the use of a CS insert included, but were not limited to, flexion instability and failure to obtain equal flexion and extension gaps. After hemostasis was ensured, all patients were closed in the standard manner.

Patients stayed in the hospital for intensive rehabilitation therapy for 2 to 3 days. Those who required further focused rehabilitation were sent to specialized facilities. All rehabilitation followed a previously established protocol. Unless a patient was considered extremely high risk, all patients were prescribed aspirin and treated with mechanical methods for deep vein thrombosis prophylaxis.

Postoperatively, patients were seen for clinical assessment approximately 6 weeks postoperatively and then at 6 months, 1 year, and annually thereafter. At follow-up appointments, patients were evaluated for further complications and were encouraged to report immediate or long-term problems associated with their surgery between appointments as well. Range of motion was assessed at every postoperative visit. At 1- and 2-year follow-up, KSS pain and function scores were recorded to assess for improvement from preoperative assessment.

At follow-up appointments, patients underwent radiographic assessment with anteroposterior, lateral, and Merchant views of the operative knee to assess for osteolysis or loosening. Radiographs were assessed and categorized using the Knee Society system for zonal analysis of radiographs. Radiolucentencies were reported when they were found to be greater than 0.5 mm.

Failure was defined as any revision procedure for aseptic reasons. Complications included postoperative flexion contractures, reoperation and lysis of adhesions, deep vein thrombosis, pulmonary embolism, and hematomas requiring reoperation.

All data were collected using standardized forms and then collated in an Excel (Microsoft, Redmont, Washington) spreadsheet. Statistical operations were performed with GraphPad Prism (GraphPad Software, Inc, La Jolla, California).

RESULTS

The patients with the CS liner had 100% survivorship at a mean follow-up of 32 months (range, 24-57 months). These patients had mean preoperative KSS pain and function scores of 59 points (range, 50-69 points) and 49 points (range, 15-70 points), respectively, which improved to postoperative KSS pain and function scores of 86 points (range, 56-100 points) and 58 points (range, 45-100 points), respectively.

One patient underwent revision of the cruciate-retaining liner to the CS liner. This 53-year-old patient had preoperative KSS function and pain scores of 56 and 60 points, respectively. The patient reported postoperative pain and instability, although no varus-valgus malalignment or anteroposterior instability was seen on clinical examination or radiographic analysis. The cruciate-retaining polyethylene insert was revised to the CS liner 6 months after the primary procedure. At 12-month follow-up after the spacer change, the patient had KSS function and pain scores of 90 and 80 points, respectively.

DISCUSSION

Despite excellent long-term success rates, improvements continue to be made in TKA designs in an attempt to improve patient satisfaction and implant durability and longevity. Due to increased wear concerns, some surgeons prefer to use a less constrained polyethylene component. However, to maintain stability, a more constrained polyethylene liner is sometimes required. The purpose of this study was to compare the standard cruciate-retaining insert with a more constrained CS insert with respect to clinical survivorship, complication rates, and func-
tional outcomes as determined by KSS pain and function scores. 

The major limitations of this study were the retrospective design and short follow-up period. It is encouraging that both cohorts had excellent results at early follow-up. However, to better assess the effect the liner constraint has on durability and longevity, long-term follow-up is required. In addition, the criteria for using a CS insert was determined intraoperatively, when the senior surgeon (M.A.M.) felt it was necessary for stability. In the future, more stringent criteria for CS insert use should be determined to more accurately describe which patients might most benefit from its use.

Regardless of the type of implant, both were used for cruciate-retaining TKAs. The excellent results seen in the current study in both patient cohorts is similar to what has been reported in the literature for these implants. 

Barrington et al reported 127 TKAs in 115 patients who had a survivorship of 97% at 120-month follow-up, and Schwartz et al reported a 97.7% survivorship at a mean 10-year follow-up (range, 10-14 years). These results promise excellent long-term results for the cruciate-retaining TKAs used in this study, despite its shorter follow-up.

Studies have shown that increased polyethylene congruency can lead to increased wear and the potential for osteolysis. An in vitro study by Fisher et al evaluated surface wear and the potential for osteolysis. An in vitro study by Fisher et al evaluated surface wear and the potential for osteolysis.17,18 An in vitro study by Fisher et al evaluated surface wear area in conforming fixed-bearing TKA. They found that a reduction in surface contact area reduced wear in low-conforming tibial polyethylene inserts.17 In a finite element analysis, Grupp et al reported increased surface contact area as congruency increased, with a corresponding decrease in polyethylene stresses.

However, few in vivo studies exist that correlate how these wear rates correspond with long-term implant durability in terms of clinical survivorship. It will be important to follow these 2 cohorts to monitor whether and how their implants fail and to determine whether the degree of constraint is related to their clinical outcomes.

The senior author (M.A.M.) typically uses the less constrained cruciate-retaining polyethylene insert when performing TKAs; however, the increased constraint of the CS polyethylene is occasionally required to maintain stability. The results of this study indicate that no differences exist in the clinical survivorship or functional outcomes between these 2 patient cohorts at short-term follow-up, and these patients will continue to be followed to assess the long-term effect, if any, of increased polyethylene congruency on these results.

REFERENCES


