Outcome and Range of Motion Using a High-flexion Cruciate-retaining TKA

ADAM S. ROSEN, DO; LORRAINE NEVILLE, BS; PAMELA A. PULIDO, BSN; SHANTANU PATIL, MD; RICHARD H. WALKER, MD; STEVEN N. COPP, MD

abstract

Increased knee flexion after total knee arthroplasty (TKA) may contribute to patients’ increased satisfaction and more active lifestyles. This study evaluated a TKA component designed for high flexion (more than 125°). The design features an anatomic sagittal femoral radius with short, flared femoral condyles to allow for femoral rollback. Fifty TKA procedures in 47 patients were evaluated prospectively regarding clinical outcomes using Knee Society knee and function scores, Short Form 12 physical component scores, and flexion measured clinically and by digital lateral supine active flexion radiographs. Preoperative and 1-year postoperative radiographs were analyzed by an independent observer.

Mean maximum flexion measured clinically was 115° preoperatively and 120° one year postoperatively, with 76% of TKAs achieving more than 120° and 44% achieving more than 125°. Sex, body mass index, and preoperative flexion were not predictors of postoperative flexion. Mean flexion by radiograph was 108° preoperatively and 111° one year postoperatively, with 31% of knees achieving more than 120° and 14% more than 125°. Mean Knee Society knee and function scores and the Short Form 12 physical component scores were 52, 55, and 32 preoperatively, respectively, and 89, 77, and 40 one year postoperatively, respectively. Of the 50 knees, 84% had improvement in their Knee Society function scores, and 76% had improvement in their Short Form 12 physical component scores. The study revealed evidence of increased early postoperative flexion with the use of a cruciate-retaining high-flexion TKA design.

The authors are from the Division of Orthopaedic Surgery (ASR, RHW, SNC) and the Shiley Center for Orthopaedic Research & Education (LN, PAP, SP), Scripps Clinic, La Jolla, California.

Dr Rosen receives royalties from Innomed; owns stock in Cadence Pharmaceuticals; and receives research funds from Stryker. Dr Walker is on the speaker’s bureau and is a consultant for Stryker. Mss Neville and Pulido and Drs Patil and Copp have no relevant financial relationships to disclose.

Correspondence should be addressed to: Steven N. Copp, MD, Division of Orthopaedic Surgery, Scripps Clinic, 10666 N Torrey Pines Rd, MS116, La Jolla, CA 92037 (copp.steven@scrippshealth.org).

doi: 10.3928/01477447-20130821-24
Historically, total knee arthroplasty (TKA) for the treatment of the arthritic knee has yielded highly satisfactory clinical outcomes. Long-term improvements in pain relief and ambulatory ability have proven to be predictable.1–7 Range of motion (ROM) necessary for the majority of activities of daily living is commonly achieved, and a postoperative ROM between 100° and 120° has provided high patient satisfaction rates. Nonetheless, occupational, recreational, and cultural interests have been shown to necessitate increased deep knee flexion (more than 120°).8–11 Closer approximation of normal, native knee ROM is likely to improve patient satisfaction.12–15 Factors that influence postoperative ROM include preoperative knee ROM, surgical technique, prosthetic design, and rehabilitation.16–19 Recent implant design changes have been aimed at improving postoperative knee flexion, but efficacy and outcome data have been mixed.20–24

The cruciate-retaining TKA implant used in the current study was designed to allow for increased flexion of 150° or more. Design features include an anatomic radius about the transepicondylar axis, which approximates that of the natural knee.25–27 Short, flared posterior femoral condyles allow for femoral rollback in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability in deep flexion. The femoral component and a matched machined polyethylene insert yield a 20° rotary arc and resultant stability.20–24

The procedures were performed by 1 of 3 surgeons (A.S.R., R.H.W., S.N.C.) using standard intramedullary instrumentation for both the femur and tibia. All tibial resections were performed with 5° of posterior slope. The surgical approach was parapatellar for 32 (64%) patients and midvastus for 18 (36%) patients. A standard midline incision averaging 13.6 cm (range, 8–16 cm) was used, and a mean tourniquet time of 98.8 minutes (range, 90–134 minutes) was reported (Table 1). All femoral, tibial, and patellar components in all knees were cemented with methylmethacrylate bone cement.

Postoperatively, all patients were placed on a TKA rehabilitation protocol that consisted of physical therapy twice daily beginning on postoperative day 1 with both passive and active ROM and weight bearing as tolerated. Mean hospital stay was 3 days (range, 2–5 days). All patients received 30 mg of enoxaparin ev-
ery 12 hours beginning 12 to 24 hours postoperatively and continuing for 10 days as part of a standard venous thromboembolism prophylaxis protocol.

Patients were seen for follow-up at 1 and 3 months and 1 year postoperatively. Knee Society knee and function scores were obtained by the surgeon. The patients completed the Short Form 12 at each follow-up. Digital anteroposterior and lateral supine active flexion radiographs28 were obtained at the same intervals.

RESULTS

Mean age of the 47 patients was 69 years (range, 49-58 years). The underlying diagnosis in 90% of knees was osteoarthritis (Table 1). One revision occurred due to infection consisting of a polyethylene exchange; this patient was excluded from all analyses of postoperative flexion.

Clinical mean maximum flexion data were available for 47 knees at 1 year follow-up. Mean ROM increased by 9° from preoperative to 1-year postoperative (Table 3). Short Form 12 scores also had an overall improvement of 76%.

Radiographic evaluation of mean maximum flexion measured by lateral supine active flexion radiographs increased by 7°, with 36% of TKAs achieving flexion of 120° or more and 22% achieving flexion of 125° or more (Table 4). Mean valgus angle was 5.7° (range, 2°-9°). Two nonprogressive 1-mm lucencies were noted in zone 1 of the tibia component, most likely representing imperfections in cementing technique. A positive correlation between clinical and radiographic analysis was seen at 3 months and 1 year postoperatively, with r values of 0.74 and 0.66, respectively. No patient had clinical evidence of significant instability because the posterior cruciate ligament was clinically intact in all patients.

DISCUSSION

The current study prospectively evaluated the flexion obtained 1 year postoperatively using a cruciate-retaining high-flexion TKA design. A previous study of the NRG knee implant (Stryker) demonstrated improved flexion, but only 23% of patients obtained 125° or more of flexion.29 Although some studies have shown that high-flexion knee designs have improved ROM and outcomes, others have shown no difference.20,22,30-34 Early outcomes using this cruciate-retaining high-flexion TKA design showed an increase in clinical ROM and function scores. Maximum clinical flexion was 120° or more in 72% of knees and 125° or more in 43% of knees at 1-year follow-up. Studies have shown variability in the clinical measurement of knee flexion with a goniometer, which may have also caused differences in the current study’s measurements.35,36 A standardized digital radiographic technique of lateral supine active flexion radiographs showed statistically less improvement in flexion. Although the clinical results were favorable, the radiographic findings revealed unanticipated less favorable improvements. Potential variability in technique with the lateral supine gravity-assisted radiographic technique may have influenced the data.

Harwin et al37 studied 4-year outcomes with the same knee design. Seventy-six of their knees were cruciate retaining. They showed an improvement from an average radiographic measured preoperative ROM of 104° to an average radiographic measured postoperative ROM of 126°.37 This is similar to the preoperative mean flexion of 108° and slightly better than the mean max-

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Knee Society and SF-12 Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>No.</td>
</tr>
<tr>
<td>Knee Society knee score</td>
<td>49</td>
</tr>
<tr>
<td>Preop</td>
<td>23</td>
</tr>
<tr>
<td>1 y postop</td>
<td>50</td>
</tr>
<tr>
<td>1 y postop</td>
<td>30</td>
</tr>
<tr>
<td>SF-12 physical component score</td>
<td>50</td>
</tr>
<tr>
<td>Preop</td>
<td>25</td>
</tr>
<tr>
<td>SF-12 mental component score</td>
<td>50</td>
</tr>
<tr>
<td>Preop</td>
<td>25</td>
</tr>
</tbody>
</table>

Abbreviations: postop, postoperative; preop, preoperatively; SF-12, Short Form 12.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Radiographic Flexion Analysis⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>No.</td>
</tr>
<tr>
<td>Flexion</td>
<td>25</td>
</tr>
<tr>
<td>3 mo postop</td>
<td>45</td>
</tr>
<tr>
<td>1 y postop</td>
<td>23</td>
</tr>
</tbody>
</table>

Abbreviation: deg, degrees; postop, postoperative. Includes patients who underwent supine gravity-assisted radiographs.
imum postoperative flexion of 113° measured radiographically for the current study.

Choo et al reported a high incidence rate of femoral component loosening in a high-flexion knee design. The implant used for the current study does not take the additional bone resection from the posterior condyles, commonly seen with the design Choo et al used. The outcomes of knees that obtain high degrees of flexion need to be followed to make sure that adverse events do not occur. No loosening was found in the current study group.

Patient satisfaction related to increased knee flexion after TKA has been evaluated over time. Societal goals of more active lifestyles extending into later decades of life have become apparent. Accordingly, goals to improve postoperative flexion have been established by surgeons and implant manufacturers alike. Although the current sample size was relatively small, the results are encouraging. Further evaluation with a larger sample size and a defined control group is needed to more reliably establish the impact of implant design changes on increased flexion. The current study results revealed evidence of increased early postoperative flexion with the use of a cruciate-retaining high-flexion TKA design.

REFERENCES


