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Primary Constrained Condylar Knee Arthroplasty without Stem Extensions for the Valgus Knee

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Avoiding stem extensions in total knee arthroplasties may decrease operative time, prosthetic cost, and canal invasion at surgery. A constrained condylar knee implant without stem extensions also likely will be easier to revise and will eliminate the risk of end of stem pain. Our hypothesis was that a constrained condylar knee implant for primary severely deformed knees would show excellent midterm results with a low rate of aseptic loosening, even without diaphyseal-engaging stems. We retrospectively reviewed 70 consecutive primary constrained condylar knee implants without stem extensions from 1998 to 2001 in 61 patients with knees in 15° valgus or greater. Forty-nine patients (55 knees) were followed up for 44.5 months (range, 2–6 years). Outcome was assessed using the Knee Society scoring system. Knee Society score and functional scores improved from 34 points and 40 points to 93 and 74 points, respectively. No radiographic loosening or wear was found. There were no peroneal nerve palsies, and no patients had flexion or medial instability. One patient was affected by chronic patellar dislocation. Constrained condylar knee implants in patients with severe valgus deformity resulted in pain relief and improved function, without substantial complications at midterm followup, without diaphyseal-engaging stem extensions.

Level of Evidence: Therapeutic study, Level IV (case series). See the Guidelines for Authors for a complete description of levels of evidence.

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Addressing a severe fixed valgus deformity is a challenge during a total knee arthroplasty (TKA). Alignment and stability can be restored by releasing lateral soft tissue structures,[26,28,29] tightening medial soft tissue structures,[13,18] or using a constrained implant.[8] A constrained implant incorporates a post in the tibial tray that fits intimately between the condyles and anterior to a nonlinked cam in the femoral component. The fit afforded by this articulation limits varus-valgus and torsional moments. Because of the increased constraint offered by these implants, concern exists about early loosening secondary to transfer of bending and rotational moments to the implant-bone interface. Consequently, authors have advocated stem extensions with constrained components to allow load-sharing over the diaphyseal portion of the tibia and femur.[5,6,27,30] Results with stemmed constrained condylar knee implants have been well documented for revision and complex primary surgery.[11,19] Approximately 85% to 90% of the patients included in these reports had excellent and good results at midterm followup with low complication rates.

Constrained condylar knee implants without stem extensions for revision TKAs produce similar clinical results compared with stemmed designs, given adequate metaphyseal bone stock.[24] Nonetheless, Brooks et al suggested stems should be used when there are substantial bone defects in the proximal tibia or when augments are used.[5] Stem extensions may be associated with leg and thigh pain near the tips of the stems, with a reported incidence of 15% to 20%.[3,4,11] The incidence of pain caused by stem extensions seems to be related to the percentage of canal filling and to the type of stem.[4] Avoiding stem extensions, when possible, would eliminate numerous adverse effects, including possible leg and thigh pain, reaming of canals and possible embolization, the technical challenge of preparing intramedullary canals, more difficult surgery at revision, and increased costs.

We asked whether a constrained condylar knee implant for primary severely deformed knees would have midterm results with a low rate of aseptic loosening, even without the addition of diaphyseal-engaging stems.

MATERIALS AND METHODS

We retrospectively reviewed 70 consecutive primary nonmodular constrained prostheses (Fig 1) (Exactech, Gainesville, FL) without stem extensions that were implanted from 1998 to 2001 in 61 patients. The study did not compare this group of patients with another group of patients, but rather used historical controls from the literature. Only patients who had primary surgery, whose knees were in at least 15° valgus, and who had a minimum of 2 years followup were included. The rationale for using this type of constrained condylar implant was to provide inherent knee stability while avoiding stem extensions and their related problems.

The implant was nonmodular because on the femoral side, the component was a standard posterior-stabilized design except for the box, which was 2 mm deeper than that of standard prostheses. This allowed engagement of a constrained-type tibial post. The femoral component was a primary component that could not be assembled with other modular parts, such as stem extensions or metal augments. The tibial component was a primary modular component with a 5-cm stem.

Twelve patients (15 knees) were lost to followup, including six who died and six who could not be contacted (nine unilateral, three bilateral implants). Families of the six deceased patients were contacted, and all reported that the eight prosthetic knees had been functioning well before death. The data for these 12 patients are not included in our results. We included only data for the patients who we examined and who had radiographs obtained at followup, so as to get reliable and accurate results. The study cohort of 49 patients included 36 women and 13 men with an average age of 72 years (range, 53–84 years). The average followup was 44.5 months (range, 2–6 years). The preoperative diagnoses were osteoarthritis in 45 patients, rheumatoid arthritis in three patients, and tuberculosis in one patient. The average preoperative valgus angle on weightbearing films was 19.7° (range, 15°–33°), and the average Ahlbäch grade for arthritis was 4 of 5 (with this grade corresponding to bony erosions up to 5 mm).[1] The Ahlbäch grade range was 3 to 5. Institutional Review Board approval was granted for this study.

According to the classification of valgus deformity by Krackow et al, all the knees in this series were rated preoperatively Grade 3 or Grade 4, which meant the presence of substantial lateral soft tissue retraction (Grade 3), and the addition of medial soft tissue laxity with incompetent medial collateral ligament (Grade 4).[9,18]

All procedures were done using a straight skin incision and medial parapatellar approach by the two senior authors (TPS, PMP). The articular surface of the tibia was resected perpendicular to the anatomic axis using an extramedullary guide. A lateral release was used in 35% of the cases. It was done subperiosteally from the tibial side only when the lateral structures were extremely tight in extension and/or in flexion and the gap configuration was trapezoid. If additional release was necessary, it was carried down from the femoral side, peeling the insertion of the lateral collateral ligament from its insertion on the condyle.

Anterior referencing was used in all knees, and the anterior rough cut and distal femoral cuts were referenced off an intramedullary guide in the femur. The distal cut always was made in 2° valgus off the anatomic axis of the femur. Rotation of the femoral component was set using Whiteside's line, ignoring the hypoplastic lateral femoral condyle. Patella tracking was assessed intraoperatively, and a lateral retinacular release was done in 22 of 55 knees (40%). The average tourniquet time was 46 minutes.

Preoperative data were obtained retrospectively through chart review and review of radiographs. Postoperatively, all patients were examined and questioned. Data included the clinical, functional, and radiographic Knee Society scores.[15] The patients were stratified into three categories (A, B, and C) according to the Knee Society classification, with A involving one knee, B involving both knees, and C involving multiple joints, based on medical problems or degree of musculoskeletal involvement.[15] There were 19 patients in Category A, five patients in Category B, and 25 patients in Category C. Postoperative films were analyzed [anteroposterior (AP) and lateral weightbearing, and axial 45° Merchant's views]. Postoperative physical examinations were done by independent examiners (AB, JHM), and scores were calculated by another research team member (JAA).

Statistical comparisons of the preoperative and postoperative clinical data were done using analysis of variance (ANOVA), chi square analysis, and Student's two-tailed t test. Statistical significance was set at $p < 0.05$.

Fig 1. The front of the nonmodular constrained (Exactech, Gainesville, FL) prosthesis is shown.

RESULTS

The average Knee Society score improved (p = 0.001) from 34 (range, 3–50 points) to 93 (range, 40–100 points) points at followup. The average Knee Society scores improved from 35 to 96 for patients in Category A (p = 0.001), from 40 to 92 for patients in Category B (p = 0.004), and from 31 to 90 for patients in Category C (p = 0.001).

The average Knee Society function score improved (p = 0.02) from 40 points (range, 0–70 points) to 74 points (range, 25–100 points). The average Knee Society function scores improved from 46 to 86 points for patients in Category A (p = 0.004), from 39 to 72 points for patients in Category B (p = 0.002), and from 35 to 63 points for patients in Category C (p = 0.01).

Average preoperative range of motion (ROM) of the knee was from −4.0° extension (recurvatum) to 103° flexion. This improved to −0.5° extension and 115° flexion at followup.

From the Knee Society scoring system, the instability score improved (p = 0.04) from 11.3 points (range, 5–15 points) to 14.9 points (range, 10–15 points). Preoperatively, nine knees (seven patients; 16%) had greater than 10° varus-valgus laxity, 22 knees (20 patients; 40%) had 6° to 9°, and 24 knees (22 patients; 44%) had less than 5°. Postoperatively, 54 knees (48 patients; 98%) had less than 5° varus-valgus laxity, whereas only one knee (one patient; 2%) had 6° to 9° varus-valgus laxity.

One patient required arthroscopy for peripatellar fibrosis (clunk) and currently is asymptomatic. Another patient had a lateral patellar dislocation that did not alter knee function. No postoperative peroneal nerve palsies occurred.

The average preoperative alignment on AP weightbearing radiographs was 19.7° valgus (range, 15°–33°) (Fig 2A). At followup, the average anatomic alignment was 6.5° valgus (range, 0°–12°) (Fig 2B). There was no correlation between lack of correction of valgus deformity and clinical outcome. The Knee Society radiographic scoring system was used to document radiolucent lines. In five knees, a radiolucent line was observed under the tibial component in Zone 1, and another knee had a line under the tibial component in Zones 1 and 2. Two more knees had radiolucencies around the femoral component in Zones 1 and 4. None of these were progressive or more than 1 mm thick. No obvious polyethylene wear or osteolysis were detected on radiographic analysis at followup.

DISCUSSION

Constrained condylar knee implants have been used for 20 years with excellent, reproducible outcomes. They have

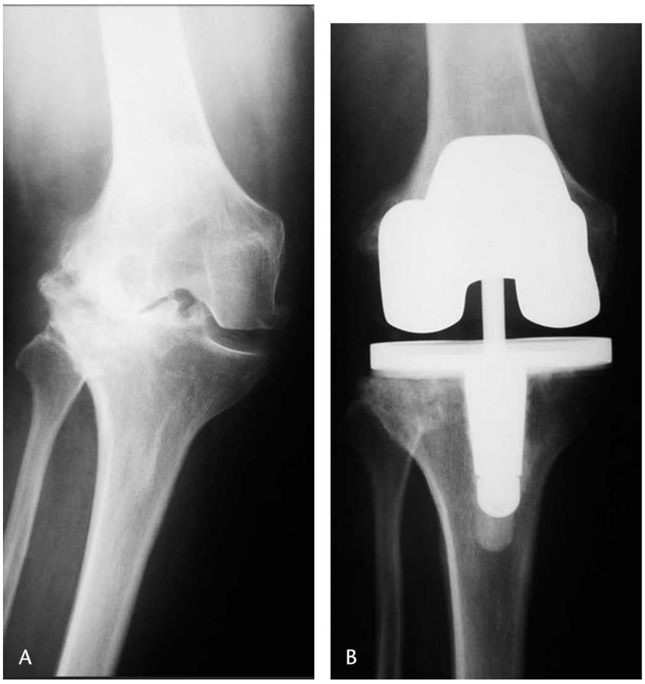

Fig 2A–B. (A) A preoperative AP weightbearing radiograph shows a severely deformed valgus knee. A nonmodular constrained prosthesis was implanted. (B) The AP weightbearing radiograph obtained at the 5-year followup is shown.

been used in revisions[2,4,7,10,11] and in difficult primary surgeries.[8,12,19] Traditionally, when a constrained condylar knee prosthesis is used, it is in conjunction with a stem extension, and the rationale for this has been to reduce the high rate of aseptic loosening, thought to be attributable to increased stresses at the bone-implant interface.[5,20,27] In revision surgeries, when the metaphyseal bone is damaged or deficient, diaphyseal fixation is mandatory, whatever degree of constraint is used. Nazarian et al described a comparable loosening rate in a cohort of 202 stemmed and stemless TKAs.[24]

We evaluated 55 severely valgus knees with constrained condylar implants without diaphyseal engaging stem extensions. The purpose of not reaming the intramedullary canal was to limit complications associated with this procedure. Our results are similar to those of other studies in which severely deformed knees that had primary TKAs were analyzed.[8,9,13,14,16,17] In the study by Easley et al,[8] constrained inserts had no adverse effects in a group of 44 valgus knees with an average preoperative deformity of 18°. The Knee Society scores in that study at an average followup of 7.8 years were similar to scores of our patients. The low complication rate in our patients was comparable to that reported by Easley et al. They reported no radiographic loosening or prosthetic failures, although their cohort was an elderly population with low activity level. Only one patient in our study experienced loosening and one patient experienced post fracture (both active and relatively young patients). Fractures of the tibial post in constrained condylar knee-type implants have been reported and seem to be related to several factors, including technical, patient-related (eg, activity level, obesity), and prosthetic design.[21,22]

Our study has several limitations. First, the study was a retrospective evaluation of the results of two experienced joint surgeons, which may not be generalizable. Second, the study lacked a matched group and involved only the nonmodular constrained prosthesis. Third, the indications for the nonmodular constrained prosthesis or the posterior stabilized implant were left to the surgeons' judgment and not standardized. However, we analyzed a substantial number of patients with adequate followup and used standardized outcome instruments.

In the study by Easley et al, the average age of the patients was 72.7 years, knees had average of 17.6° preoperative valgus, and there were no major complications using a primary stemmed constrained condylar knee implant in 28 knees.[8] In our series, the intramedullary stems were eliminated, decreasing the risk of fat embolization acutely and stem tip pain chronically. Operative time and costs also were decreased. We avoided peroneal nerve injury, a recognized complication with an incidence of 3% to 4% when extensive lateral release is used.[14,17,25]

Studies on lateral releases for the valgus knee provide options for correcting fixed deformities.[9,18,28] However, the rate of recurrent instability after these releases is reported to be as much as 4% to 8%.[9,23,24] We think that the intimate contact between the large post and intercondylar notch provides initial stability, acting as an internal splint to allow the compromised medial collateral ligament time to accommodate valgus loads. The post may deform over the life of the constrained condylar knee implant. However, we think the initial stability accounts for the success of this design, and later small deformation may be inconsequential. Additionally, concern regarding the potential for stress transfer to the bone-implant interfaces was not found in this group of patients at midterm followup. We had no component loosening and few radiolucent lines, all of which were less than 1 mm and nonprogressive. Investigators, in clinical studies,[5,6,20,27,30] have advocated stems to decrease these theoretical stress transfers. However, no data were available to show any increased loosening with constrained condylar knee implants that did not use stem extensions. Stems in the canals can lead to increased embolization, cost, and surgery time, and would make future revisions more difficult. Additionally, Rose et al, in a biomechanical study, reported that stems may not protect the interfaces.[25]

We documented our experience with constrained condylar knee implants without stem extensions in valgus knees at midterm followup. To our knowledge, this is the first report of this implant being used in primary TKAs. A constrained condylar knee implant is reliable for providing stability and correcting deformity and should be considered for use in a knee with a severe valgus deformity with an incompetent medial collateral ligament and adequate metaphyseal bone quality.

In the intermediate term, we found that a constrained condylar knee implant without stem extensions functions well in patients with valgus knees having primary TKAs. However, additional study at longer followup is required to obtain a definitive conclusion.

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