Research Article

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Clinical and Functional Outcomes: Primary Constrained Condylar Knee Arthroplasty Compared With Posterior Stabilized Knee Arthroplasty

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Abstract

Introduction: Constrained condylar knee (CCK) prostheses are commonly used in difficult primary total knee arthroplasty and revision total knee arthroplasty. We postulate that the use of CCK prostheses in primary knee arthroplasty may result in decreased range of motion but with better patient-reported functional scores compared with primary posterior stabilized (PS) knee prostheses because of increased varus and valgus stability from increased constraint.

Methods: We conducted a case-control study using prospectively collected data on functional outcome scores and range of motion preoperatively and at 6 months and at 2 years. Thirty-eight patients with primary CCK arthroplasty were matched with 38 patients with primary PS knee arthroplasty treated by a single surgeon. Institutional review board approval was obtained. Analysis was done using the independent *t*-test.

Results: Total 76 patients with 61 (80.3%) female patients, 30 (39.5%) left knees, and 9 (11.8%) valgus knees. There was no significant difference in preoperative age (CCK arthroplasty 70.7 ± 6.0 years versus PS knee arthroplasty 68.5 ± 5.2 years; $P < 0.085$), body mass index (27.2 ± 4.4 versus 26.3 ± 5.2; $P < 0.44$), Oxford Knee Score (35.8 ± 7.8 versus 36.0 ± 7.6; $P < 0.92$), and Medical Outcomes Study 12-Item Short Form (SF-36) scores and knee extension (8.0° ± 6.7° versus 7.7° ± 7.6°; $P < 0.84$). There was no significant difference in preoperative knee flexion (106.0° ± 22.9° versus 117.3° ± 20.1°; $P < 0.026$). There was no significant difference in 6-month knee extension (4.5° ± 6.8° versus 4.1° ± 4.5°; $P < 0.80$), knee flexion (110.5° ± 15.8° versus 110.9° ± 15.5°; $P < 0.92$), Oxford Knee Score (18.9° ± 3.4° versus 20.1° ± 5.3°; $P < 0.27$), and SF-36 scores. There was no significant difference in 2-year knee extension (1.8° ± 5.7° versus 1.5° ± 4.0°; $P < 0.82$), knee flexion (111.3° ± 13.6° versus 115.0° ± 16.5°; $P < 0.30$), Oxford Knee Score (18.5° ± 3.7° versus 18.2° ± 4.2°; $P < 0.77$), and SF-36 scores.

Conclusion: The use of CCK prostheses in primary knee arthroplasty gives similar clinical and functional outcomes at 2 years as those of PS knee prostheses, despite increased constraint.

The constrained condylar knee (CCK) prosthesis has been used in difficult primary and revision total knee arthroplasties in which increased coronal plane stability is required through the use of a larger tibial post with a deep femoral box.[1] The routine use of the CCK prosthesis for uncomplicated primary total knee arthroplasty has not been advocated in view of the increased stresses transmitted through the bone-implant interface with increased constraint.[2–4] We postulated that the use of the CCK prosthesis for primary total knee arthroplasty might result not only in decreased range of motion but also in better patient-reported functional scores compared with the primary posterior stabilized (PS) knee prosthesis because of increased varus and valgus stability from increased constraint. With increased stability from increased constraint, we postulated that patients with the CCK prosthesis may report higher functional outcome scores in the early postoperative rehabilitation period.

Goal

The goal of our study was to compare the patient-scored functional outcome scores and objective range of motion between patients who underwent primary total knee arthroplasty with a CCK prosthesis and patients who underwent primary total knee arthroplasty with a PS prosthesis, all treated by the same single surgeon.

Methods

Institutional review board approval at our institution was obtained to conduct a matched case-control study. Using prospectively collected data from our Orthopaedic Diagnostic Centre on functional outcome scores and range of motion preoperatively and at 6 months and 2 years, the records of 113 patients who underwent primary total knee arthroplasty were reviewed, and 42 patients with a CCK prosthesis from 2011 to 2013 treated by a single surgeon were identified. Four patients were lost to follow-up and were excluded. The records of the remaining 38 patients were matched with the records of 38 patients with primary PS knee arthroplasty, treated by the same surgeon during the aforementioned time period.

All surgical procedures were performed with patients under general or regional anesthesia using a standard medial parapatellar approach, with the use of a tourniquet that was inflated at the start of the procedure and kept inflated until the wound was closed. The decision to use a CCK prosthesis the surgeon depending on the patient's deformity, preoperative ligamentous stability, and intraoperative assessment of competency of the collateral ligaments as well as on-table assessment of coronal plane stability after soft-tissue releases were done.

All implants were cemented. In the PS group, a Depuy-Synthes PFC Sigma (35 patients), Zimmer NexGen Legacy (2 patients), or Smith & Nephew Legion (1 patient) knee prosthesis was implanted. In the CCK group, either a Smith & Nephew Legion with constrained insert (5 patients) or Zimmer NexGen Legacy CCK (33 patients) prosthesis was implanted. Postoperative rehabilitation was done per the department protocol for patients who underwent total knee arthroplasty, with full weight-bearing ambulation as tolerated on the first postoperative day. Plain radiographs were taken on the first postoperative day and on each subsequent follow-up visit at 1 month, 3 months, 6 months, and 1 year after surgery and subsequently annually.

Data collected included functional scoring by the Oxford Knee Score, quality-of-life scoring using the Medical Outcomes Study 36-Item Short Form (SF-36) questionnaire, and range-of-motion measurements by an independent observer preoperatively and at 6 months and 2 years after surgery. Analysis was done using the independent *t*-test on SPSS for Windows.

Forty-two patients would be the required minimum sample size for a meaningful important difference in the Oxford Knee Score of five points between the two groups of patients, as recommended by Beard et al,[5] with a mean 2-year Oxford Knee Score of 18 and an SD of 5.6, based on previously presented unpublished data from our institution, with a two-sided significance of 0.05 and a power of 0.8.

Results

From a total of 76 patients, 61 (80.3%) were female. Thirty (39.5%) knees were left knees and 9 (11.8%) were valgus knees. The mean duration of follow-up was 5.2 ± 0.77 years (4.2 to 6.9 years). There was no significant difference in preoperative age, body mass index, Oxford Knee Scores, and knee

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extension between patients who received either a CCK prosthesis or PS prosthesis (Table 1). There was no significant difference in preoperative SF-36 scores (Figure 1; Supplemental Table, http://links.lww.com/JG9/A3). There was a significant difference in preoperative knee flexion, with the PS group having greater preoperative knee flexion compared with that in the CCK group (Table 1).

The mean duration of hospitalization after surgery was 6.5 ± 3.3 days. There was no significant difference in length of stay after surgery between patients receiving the CCK prosthesis (7.1 ± 3.1 days) or PS prosthesis (6.0 ± 3.3 days) ($P < 0.18$). There was no significant difference between the groups in knee extension, knee flexion, and Oxford Knee Scores at 6 months of follow-up (Table 2). There was no significant difference in SF-36 scores at 6 months of follow-up (Figure 1; Supplemental Table, http://links.lww.com/JG9/A3). Despite differing values in preoperative knee flexion between the groups, there was no significant difference in 2-year knee extension, knee flexion, Oxford Knee Score (Table 3), and SF-36 scores (Figure 1; Supplemental Table, http://links.lww.com/JG9/A3).

One patient who received a PS prosthesis developed a superficial wound infection from a stitch abscess 1 month after primary surgery, which required incision and drainage. Two patients in the CCK groups had additional plating for intraoperative lateral femoral condyle fractures because of the larger box cut required to accommodate the CCK prosthesis. There were no infections in the CCK group. One patient in the CCK group who had been diagnosed with metastatic breast cancer died of pneumonia with septic shock 3 years after primary surgery. No radiographic evidence of implant loosening was observed and no revision surgery was performed in either group.

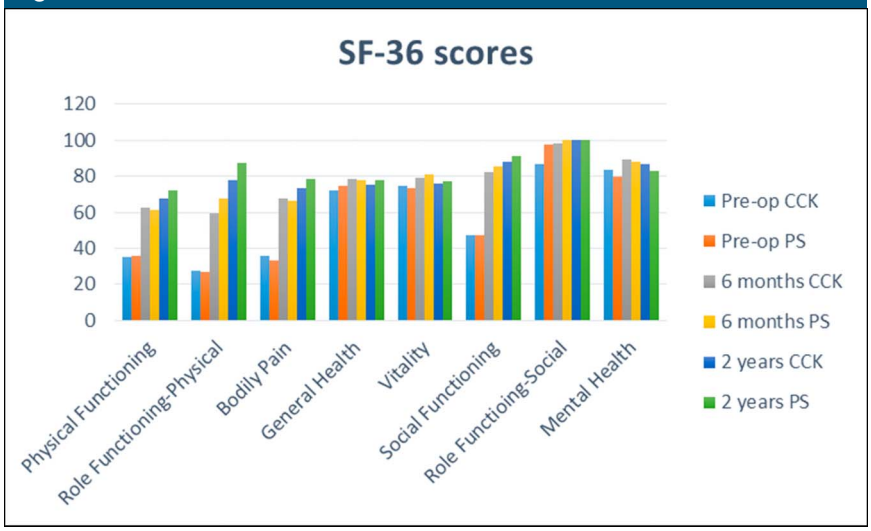
Table 1

Preoperative Demographics, Range of Motion, Alignment, and Oxford Knee Scores

Variable	Implant		*P*
	CCK (n = 38)	PS (n = 38)	
Age (yrs)	70.7 ± 6.0	68.5 ± 5.2	0.085
BMI (kg/m^2)	27.2 ± 4.4	26.3 ± 5.2	0.44
Knee extension (°)	8.0 ± 6.7	7.7 ± 7.6	0.84
Knee flexion (°)	106.0 ± 22.9	117.3 ± 20.1	0.026
Preoperative radiographic alignment (°)	16.0 ± 7.9	13.1 ± 7.3	0.62
Oxford Knee Score	35.8 ± 7.8	36.0 ± 7.6	0.92

BMI = body mass index, CCK = constrained condylar knee, PS = posterior stabilized

Figure 1



Bar graph of preoperative and 6-month and 2-year postoperative Medical Outcomes Study 36-Item Short Form (SF-36) scores between constrained condylar knee (CCK) and posterior stabilized (PS) groups.

Discussion

In our study population, we could not demonstrate a significant difference in range of motion or functional scores between patients who underwent primary total knee arthroplasty with a CCK prosthesis compared with a PS prosthesis at 6 months and 2 years. These results are similar to those of a case-control study by King et al.[6] In that study, a modular prosthesis that allowed for switching of tibial inserts of different levels of constraint without changing the femoral component was used. Similar results were obtained in obese patients who received the CCK prosthesis to gain increased stability.[7] Hence, we cannot recommend the routine use of the CCK prosthesis, with its associated increased implant cost, complexity of the procedure, and greater bone

Table 2

Range of Motion and Oxford Knee Scores at 6 Months

Variable	Implant		*P*
	CCK (n = 38)	PS (n = 38)	
Knee extension (°)	8.0 ± 6.7	4.1 ± 4.5	0.80
Knee flexion (°)	110.5 ± 15.8	115.0 ± 16.5	0.92
Oxford Knee Score	18.9 ± 3.4	20.1 ± 5.3	0.27

CCK = constrained condylar knee, PS = posterior stabilized

Table 3

Range of Motion and Oxford Knee Scores at 2 Years

Variable	Implant		*P*
	CCK (n = 38)	PS (n = 38)	
Knee extension (°)	1.8 ± 5.7	1.5 ± 4.0	0.82
Knee flexion (°)	111.3 ± 13.6	110.9 ± 15.5	0.30
Oxford Knee Score	18.9 ± 3.4	18.2 ± 4.2	0.77

CCK = constrained condylar knee, PS = posterior stabilized

removal, for the explicit purpose of improving range of motion and functional outcome scores in the setting of primary knee arthroplasty compared with a PS prosthesis. Conversely, the use of a CCK prosthesis, if indicated, because of preoperative or intraoperative instability or difficult ligament balancing would not be detrimental to the patient, given the similar outcomes between both groups of patients.

We recognize limitations in our study in terms of patient selection. Because of our small sample size, we were unable to match for other patient variables, such as age, range of motion, deformity, and implant system. Our study compared similar patients who received either a CCK or a PS prosthesis for primary total knee arthroplasty performed by the same single surgeon. However, the decision to implant a CCK prosthesis rather than a PS prosthesis was based on this surgeon's preoperative and intraoperative assessment and was not protocol driven, although we had taken cases from this single surgeon to reduce this variability in patient selection. The ideal study would be a randomized control trial, although we recognize the difficulty in conducting such a trial with the difference in implant costs between CCK and PS prostheses.

We do not have long-term follow-up data of our patients beyond 6 years, and thus, we cannot draw conclusions on the longevity of the CCK prosthesis in our patient population. Concerns with the longevity of the CCK prosthesis include aseptic loosening and tibial post fracture.[8,9] However, long-term follow-up studies of patients with the CCK prosthesis used in primary total knee arthroplasty have shown favorable implant survival of up to 10 years.[9–15] The greater amount of bone resected for the implantation of a CCK prosthesis, with the use of more augments and possibly greater constraint, would make revision surgery more technically challenging compared with that of a PS prosthesis.[16] The two patients who sustained intraoperative fractures of the lateral femoral condyle in the CCK group highlight the inherent risks and technical challenges in the use of the CCK implant, possibly because of the larger box cut required.

After infection, aseptic loosening, wear, and malalignment, an additional cause of failure of primary total knee arthroplasty is unrecognized or unaddressed instability.[17–20] Fehring et al[20] reported that, after infection, the second most common cause of early revision within 5 years after primary total knee arthroplasty is instability. The CCK prosthesis provides an element of coronal plane stability, although we are unable to comment on whether the routine use of a CCK prosthesis can prevent late instability and reduced revision rates in primary knee arthroplasty compared with using a PS prosthesis.

We recognize the availability of newer, more versatile implant designs that allow for on-table switching from a PS tibial insert to a more constrained condylar tibial insert, with a larger tibial post akin to a CCK prosthesis, without the need to recut the distal femur or use stems. There is no need to recut the femur or use stems because of a common femoral box cut across different levels of constraint, which may be used without femoral or tibial stems.[6,21] Moussa et al[22] reported that there is an increased revision rate in a stemless constrained condylar prosthesis compared with a PS prosthesis. The basic tenets of careful soft-tissue balancing for stable total knee arthroplasty with equal flexion and extension gaps still hold true; however, a case can be made for the routine use of a more constrained prosthesis, such as a CCK prosthesis, prophylactically. This can be done to prevent revision and poorer outcome even in apparently uncomplicated

and balanced knee total knee arthroplasty in patients who may be at risk of developing late instability because of subsequent ligamentous laxity.

Conclusion

The use of a CCK prosthesis in primary knee arthroplasty produces similar range of motion and functional scores at 6 months and 2 years of follow-up, with no added benefit or functional impairment over a PS prosthesis.

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