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ORIGINAL ARTICLE

Primary constrained condylar knee arthroplasty in severe varus deformity: a prospective 5-year functional follow-up study in Iraqi patients

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Abstract

Purpose The outcomes of the constrained condylar knee (CCK) implant used during primary total knee arthroplasty (TKA) in knees with severe varus in patients from low- and middle-income countries (LMICs) such as Iraq are not known. Hence, this study aimed to analyze and report the functional outcome of CCK TKA in patients with severe varus deformities at the end of 5 years in Iraqi patients.

Methods In this prospective study, pre- and post-operative (at the end of 5 years) clinical outcome using Knee Society Score (KSS) and radiological deformity using hip-knee-ankle (HKA) angle was analyzed in 76 CCK TKAs (20 bilateral and 36 unilateral TKAs) performed in 56 patients with severe varus deformity (> 15°).

Results At a mean follow-up of 60.3 months (range 60–68 months), the mean preoperative KSS knee score of 6.6 ± 4.5 improved significantly ($p < 0.0001$) to 87.2 ± 6.6 and the mean preoperative KSS function score of 7.1 ± 6.4 improved significantly ($p < 0.0001$) to 70.4 ± 7.8. The function score was good to excellent in 64.3% (36 patients), fair in 28.5% (16 patients), and poor in 7.1% (4 patients) at the end of 5 years. The mean preoperative HKA angle significantly improved ($p < 0.001$) from 25.5° ± 6° varus (range 17°–37°) to 3° ± 2.5° varus (range 0°–7.5°) at final follow-up.

Conclusion The CCK implant significantly improved pain and function in patients with severe varus deformity at the end of 5 years. The CCK implant is a good option during primary TKA in severe varus knees in patients from LMICs and can help achieve clinical outcomes similar to patients from high-income countries.

Keywords Constrained condylar knee · Total knee arthroplasty · Knee Society Score · Varus deformity · Knee

Introduction

Although the posterior stabilized (PS) design is commonly used during primary total knee arthroplasty (TKA) in arthritic knees, a higher constrained implant design is sometimes indicated [1]. Higher implant constraint is frequently used in knees with severe deformities where there may be excessive attenuation of the collateral ligaments, significant bone loss, and rigid deformities which may require excessive release, which makes achieving ligament balance and stability challenging with a typical PS TKA design [1, 2].

The constraint condylar knee (CCK) implant design is a higher constrained implant design used in primary TKA. There are few studies in the literature that have reported the results of using constrained condylar components with high clinical success rates [3–11]. However, the outcomes of the CCK implant used during TKA in knees with severe varus

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in patients from low- and middle-income countries (LMICs) such as Iraq are not known. Since patients from LMICs undergoing TKA surgery have a very different demographic profile and clinical presentation and undergo this procedure in a different setting when it comes to training, resources, and management guidelines when compared to high-income countries (HICs), outcomes of CCK TKAs in patients from HICs are not translatable to patients in LMICs [12].

The primary objective of this study was to assess the mid-term clinical outcome of primary CCK TKA in a population from a LMIC, the results of which can act as a benchmark for comparison of outcomes of CCK TKAs performed in other LMICs and low-resource setting. Hence, this study aimed to analyze and report the functional outcome of CCK TKA in patients with severe varus deformities at the end of 5 years in Iraqi patients. We hypothesized that the functional outcomes of CCK TKA in patients with severe varus deformities at the end of 5 years in Iraqi patients would be similar to patients who underwent this procedure elsewhere in the world.

Patients and methods

Study design

We prospectively studied patients who underwent primary TKA for knee arthritis between March 2015 and November 2017 at the orthopedic department of a tertiary care hospital to determine functional outcomes in patients who underwent TKA using the CCK implant design. The study protocol was approved by an institutional review board and ethics committee, and all participants signed an informed consent form for participation in this study. The study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Study population

The inclusion criteria were patients who underwent primary TKA using the CCK implant design for severe knee arthritis with significant knee instability (mediolateral and anteroposterior) and suspected unilateral collateral ligaments attenuation as confirmed by physical examination and knee x-ray findings of subluxated joint, severe femorotibial varus deformity of > 15° varus, moderate to severe tibial plateau bone loss, and attenuated lateral collateral ligament. The exclusion criteria were knees with known traumatic rupture of collateral ligaments, knees with traumatic arthritis, knees with rheumatoid arthritis, patients with a follow-up of < 5 years, and patients lost to follow-up.

Preoperative evaluation

All patients were evaluated preoperatively with detailed history, physical examination of the knee, radiological evaluation using full-length hip-to-ankle and knee radiographs, and laboratory investigations. In terms of clinical score, The Knee Society knee and function score was used in all patients pre- and post-operatively.

Surgical procedure

All TKAs were performed under general or spinal anesthesia based on the requirement as assessed by the anesthetist. The same surgical team performed all surgeries, and a midline knee skin incision and medial parapatellar approach to the knee joint were used in all cases. The femur first technique was used in all cases. The distal femoral cut was performed using an intramedullary guide using the transepicondylar axis (TEA) as a reference to determine the femoral rotation (neutral rotation relative to the TEA). Using an intramedullary guide, the tibial cut was performed perpendicular to the tibial mechanical axis with a 7° posterior slope. The surgeon performed medial and posteromedial soft-tissue releases to achieve medial opening and deformity correction in the coronal (varus) and sagittal (flexion) planes when required, and the mediolateral soft tissue stability was assessed using spacer blocks at 0° extension and 90° flexion. The surgeon's decision to use a CCK implant (NexGen LCCK®, Zimmer Biomet, Warsaw, IN) was based depending on the severity of patient's preoperative deformity (femorotibial varus deformity of > 15° varus) and ligamentous instability, and intraoperative assessment of coronal mediolateral stability after appropriate soft-tissue releases were performed. The indication for the CCK implant in the current study was a varus or valgus laxity of > 3 mm with the knee at 0° extension, mid-flexion, and 90° flexion after the appropriate soft-tissue releases have been performed and when the stability could not be obtained with a PS prosthesis trial. Three knees had a medial tibial bone defect which required half-block tibial augments. Stem extenders were used in all cases. The stem's thickness and length were decided based on the availability of the thickest and shortest stem, which provided good intramedullary fixation and the tibial augment thickness. After trialing, the appropriate size implants were cemented, and the wound closed in layers under two closed suction drains. Intravenous antibiotics were infused half an hour before induction of anesthesia and continued on the first and second postoperative days. Oral anticoagulants were given 12 h after surgery and continued for additional 21 days. All patients

were mobilized on the next day after drain removal and underwent physiotherapy by continuous passive motion machine. All patients were discharged on the 3rd postoperative day, and stitches were removed after 14 days from the surgery date. All patients were followed up clinically and radiologically at 6 weeks, 12 weeks, 6 months, 12 months, and annually after that.

Study outcome measures

Demographic, clinical outcome, and radiographic data used in this study were obtained from all patients preoperatively and at final follow-up. Pre- and post-operative clinical functions were measured using the Knee Society Score (KSS). Each knee was considered a separate case for the KSS knee score, whereas the KSS function score was measured for each patient. An online KSS scoring system (www.orthopaedicscores.com) was used to record and calculate KSS scores in all patients. Pre- and post-operative knee deformities were measured on full-length hip-to-ankle radiographs as the hip-knee-ankle (HKA) angle denoted by the medial angle between the femoral mechanical axis (line joining the center of the femoral head and the center of the distal femur) and the tibial mechanical axis (line joining the center of the tibial plateau and the center of the ankle plafond).

Statistical analysis

Pre- and post-operative (at final follow-up) clinical outcomes as obtained from KSS knee and functional scores and knee deformity on radiographs were compared using paired *t* test and Fisher's test. A *p* value of ≤ 0.05 was considered significantly significant. Statistical analysis was performed using the SPSS (ver. 24) statistical software.

Results

A total of 282 patients underwent 425 primary TKAs at the department during the study period. Based on the inclusion criteria, 74 patients underwent 96 primary TKAs using the CCK implant design. Out of these 96 primary TKAs, 5 TKAs due to post-traumatic arthritis, 3 TKAs due to rheumatoid arthritis, 2 TKAs were excluded due to pre-existing traumatic collateral injury, 3 TKAs follow-up of < 5 years, and 7 TKAs (5 patients) were lost to follow-up. Hence, data from 76 primary CCK TKAs (20 bilateral TKAs and 36 unilateral TKAs) performed in 56 patients were analyzed. Out of the 36 unilateral CCK TKAs, 20 knees had a PS TKA on the contralateral side before or after our index surgery. The mean age was 63.8 ± 6.6 years (range 50–75 years), with 64.3% of patients being females (36/56 patients). The demographic details of the study population are summarized in Table 1.

Table 1 Baseline characteristics of the study population

Parameters	Values
Number of patients	56
Number of knees	76
Mean age (years)	63.8 ± 6.6 (62–65.5)
Age distribution (years)	
50–59	11 (19.5%)
60—69	36 (64.5%)
≥ 70	9 (16%)
Gender distribution	
Females	36 (64%)
Males	20 (36%)
Operated side distribution	
Left	48 (63%)
Right	28 (37%)

All values given as mean ± standard deviation (95% confidence interval) or number (percentage)

At a mean follow-up of 60.4 months (range 60–68 months), the mean KSS knee score at final follow-up significantly improved ($p < 0.0001$) to 87.2 ± 6.6 when compared to the mean preoperative KSS knee score of 6.6 ± 4.5 (Table 2). The categorization of KSS knee score revealed that all the knees (100%) had poor scores preoperatively, which improved to excellent score in 68 knees (89.5%), and a good score in 8 knees (10.5%) at final follow-up. Similarly, the mean KSS function score at final follow-up significantly improved ($p < 0.0001$) to 70.4 ± 7.8 (range 55–80) when compared to the mean preoperative KSS function score of 7.1 ± 6.4 (range 0–20). The categorization of KSS function score revealed that all patients (100%) had poor function preoperatively, which improved to excellent function in 12 patients (21.5%), good function in 24 patients (43%), fair function in 8 patients (14%), and poor function in 12 patients (21.5%) at final follow-up.

The mean preoperative knee deformity (HKA angle) significantly improved ($p < 0.001$) from 25.5° ± 6° varus (range 17°–37°) to 3° ± 2.5° varus (range 0°–7.5°) postoperatively (Table 2).

Discussion

This study found significant improvement in the knee and functional scores, with 89.5% of knees having excellent KSS knee scores and 64.5% of patients having good to excellent function following CCK TKA for severe knee varus deformity at the end of 5 years of the index surgery. These clinical outcomes were similar to outcomes, in the

Table 2 Comparison of pre- and post-operative variables among the study group

Deformity degree	Preoperative	Postoperative	*p* value
Number of knees	76	76	–
Mean knee deformity (degrees)	25.5 ± 6.0 (24–27)	3.0 ± 2.5 (2.5–3.5)	< 0.0001
Mean knee score	6.6 ± 4.5 (5.5–7.6)	87.2 ± 6.6 (85.6–88.7)	< 0.0001
Mean function score	7.1 ± 6.4 (5.6–8.5)	70.4 ± 7.8 (68.6–72.1)	< 0.0001

All values given as mean ± standard deviation (95% confidence interval); *p* value < 0.05 is statistically significant

mid-to long-term, reported in patients from other ethnic/geographic populations. Feng et al. [3], in an analysis of 48 CCK TKAs performed in Chinese patients with severe varus knee deformity, reported significant improvement in KSS knee and function scores at the end of 6 years. Similarly, Mancino et al. [6], in an analysis of 54 CCK TKAs performed in Italian patients with severe varus knee deformity, reported significant improvement in KSS knee and function scores at a mean follow-up of 9 years. However, both these studies included patients with severe varus and valgus deformities due to post-traumatic and rheumatoid arthritis [3, 6], whereas the current study analyzed only patients with severe varus deformity primarily due to osteoarthritis.

A higher constraint TKA implant such as the CCK design has the theoretical risk of reducing postoperative function due to limitations in rotation and coronal plane mobility, and total arc of knee motion. However, King et al. [13], in a matched-pair analysis of 68 primary TKAs, reported no difference in knee range of motion between the PS and CCK implants. This is confirmed by previous studies and the current one where patients who underwent primary CCK TKA had good to excellent function during mid-and long-term follow-up. However, 35.5% of patients in the current study had fair to poor function at the end of 5 years. A possible explanation for this could be the presence of pain and arthritis in the contralateral unoperated knee in 28.5% of patients who underwent unilateral CCK TKA.

The CCK prosthesis is typically used in primary TKA in the presence of severe bone loss and significant collateral ligaments insufficiency. The high degree of varus deformity with concomitant flexion contracture in patients in the current study resulted in unstable knees due to attenuated lateral collateral ligament with mediolateral subluxation of the knee joint. Although appropriate soft-tissue releases may help achieve soft-tissue balance, it may not always be achievable in severe varus deformities, and the CCK implant may be indicated. Cheung et al. [14] recommend the CCK constraint implant as an effective, less technically demanding alternative to ligament reconstruction in severe varus deformities of > 20° undergoing primary TKA. Furthermore, the CCK implant has shown an excellent survival rate of 96% at the end of 10 years despite an increase in constraint [7, 8].

Developing countries or LMICs such as Iraq, have a unique patient demographics where patients present late with severe deformity making the index arthroplasty procedure more challenging. Furthermore, hospitals in LMICs often lack proper tertiary-level operating facilities, experienced and trained surgeons and healthcare staff, financial resources, and access to medical insurance to bear the high cost of a constraint knee implant, adequate perioperative patient care, and availability of imported constraint knee implant [12]. Despite these burdens, TKAs are being done in increasing numbers in developing countries. However, patient outcome data are lacking regarding TKA surgery in severe varus deformities, especially with constraint implant design. To the best of our knowledge, the current study is the first and the largest study which has reported a 5-year functional outcome of CCK TKA for severe varus deformity in patients from an LMIC. However, this study had a few limitations. First, the current study lacked a control group to compare functional outcomes of the CCK implant with a lower constraint design such as the PS implant. Second, the intraoperative decision to use a CCK TKA implant in the current study was based on the surgeon's subjective assessment of knee stability and his experience and preference, which may have introduced a selection bias. Third, this study presents mid-term functional outcomes, and long-term follow-up is required to determine the survival and function of the CCK implant in severe varus knees. Finally, this study should have ideally been conducted as a multicentric study with a larger cohort. However, the CCK TKA implant is not commonly available in our country, and given the high cost of the implant and financial resource constraint among the population is not performed commonly in our population. Hence very few tertiary centers perform primary CCK TKAs in large numbers and therefore a multicentric study design with a large patient cohort was not feasible for this study.

Conclusion

In conclusion, the CCK implant significantly improved pain and function in patients with severe varus deformity at the end of 5 years. The CCK implant is a good option during primary TKA in severe varus knees in patients from LMICs

and can help achieve clinical outcomes similar to patients from HICs.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

IRB/ethical approval This study has been approved by an Institutional Review Board and Ethics Committee and has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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