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ORIGINAL PAPER

Clinical outcome and survival rate of condylar constrained knee prosthesis in revision total knee arthroplasty: an average nine point six year follow-up

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Abstract

Purpose Condylar constrained knee prostheses (CCK) are increasingly used in revision total knee arthroplasty (rTKA), but the clinical effectiveness and long-term survival remain a debate. The purpose of this study is to report the long-term clinical and radiographic outcome, implant survival rate, and surgical safety of revision total knee arthroplasty with condylar constrained knee prosthesis.

Methods A retrospective cohort study was performed on patients undergoing rTKA with CCK. The cases who received rTKA with CCK from January 2005 to January 2022 were selected. The duration of operation, the estimated perioperative blood loss, and the intraoperative blood transfusion rate were recorded to evaluate surgical safety. The pain visual analog scale (VAS), range of motion (ROM), the Hospital for Special Surgery (HSS) score, the Knee Society Score (KSS), the Western Ontario and McMaster University Osteoarthritis Index (WOMAC), and the Oxford knee score (OKS) was recorded to assess clinical outcome. Standard anteroposterior, lateral, skyline and long-standing AP radiographs of the lower limbs were conducted to assess radiographic outcome. Implant survival was analyzed by Kaplan–Meier survival estimates.

Results Fifty-five cases were followed up for an average of 9.6 years (1–18 years), including 16 males and 38 females, with an average age of 66 and an average BMI of 26.9 kg/m^2. The main reasons for revision were periprosthetic infection (32 knees, 58.2%) and aseptic loosening (13 knees, 23.6%). The duration of operation was 149 ± 56.2 min. The perioperative blood loss was 973.6 ± 421.6 ml. At the last follow-up, VAS (8.0 ± 1.1 to 1.3 ± 1.4), ROM (82.7° ± 26.1° to 108.4° ± 11.8°), HSS (45.0 ± 10.4 to 85.3 ± 8.6), KSKS (38.4 ± 12.1 to 88.5 ± 12.0), KSFS (19.6 ± 12.9 to 68.8 ± 15.1), WOMAC (67.9 ± 12.5 to 14.4 ± 9.5), and OKS (9.9 ± 4.2 to 41.6 ± 7.7) were significantly improved ($P < 0.001$). A total of five complications were observed, all of which were periprosthetic infection. Non-progressive radiolucent lines were observed in 26 knees (47.3%). The 10-year survival rate for no operation was 96.0%. The ten year survival rate for no revision was 98.0%.

Conclusion The use of CCK prosthesis for rTKA can achieve good long-term efficacy and prosthesis survival.

Keywords Total knee arthroplasty · Revision · Constrained condylar knee · Clinical results · Survival analysis

Introduction

Total knee arthroplasty (TKA) is considered the most successful treatment for end-stage knee arthritis [1]. However, due to the aging population, an increasing number of younger patients are undergoing TKA, resulting in a rise in revision total knee arthroplasty (rTKA). Statistics indicate that rTKA accounts for 2.4% of all knee replacements in China, with the knee revision rate showing an upward trend from 2013 to 2018 (from 2.3 to 2.5%) [2]. Common reasons for revision of TKA include polyethylene wear, aseptic loosening, periprosthetic infection, instability, and abnormal alignment [3]. In the latest large-sample studies,

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infection and aseptic loosening have emerged as the primary causes of failed TKA [2, 4]. Revision TKA often presents complex challenges, including ligament dysfunction, bone defects, and severe varus and valgus deformities [5]. The surgical difficulty is significantly higher than that of primary TKA, which places higher requirements on the design and characteristics of the prosthesis. In cases of rTKA with severe deformity and ligament damage, primary prostheses like posterior stabilized (PS) or cruciate retaining (CR) are inappropriate. The reconstructions of knee often necessitate the utilization of more restrictive prostheses, such as condylar constrained knee (CCK) and rotating hinged knee (RHK) [6]. Although some studies have shown that rTKA using PS prosthesis can achieve similar patient satisfaction and prosthesis survival as primary TKA [7], Digennaro et al. [8] reported that the rates of utilization for prostheses in rTKA were CCK (41.8%), RHK (31.7%), PS (24.9%), and CR (1.5%). Both the CR group (75.1%) and PS group (75.3%) demonstrated a significantly lower 10-year prosthesis survival rate compared to the CCK group (87.5%) and the RHK group (81.7%). There is still controversy about the CCK and RKA in rTKA [9]. This study mainly explored the application of CCK in rTKA.

Previous follow-up studies of CCK have proven that CCK can achieve satisfactory mid-term clinical outcomes in complex primary TKA and rTKA [10–13]. Kim et al. [14] reported good functional improvement and 91% prosthesis survival of CCK in rTKA with an average of 19.2-year follow-up, which is the longest follow-up result so far. However, some studies have highlighted a potential concern, while CCK restricts anterior and posterior condyle movement, it could elevate contact pressure on the articular surface, possibly resulting in increased prosthetic wear and aseptic loosening rates[15, 16].

Currently, there is a limited number of studies examining the long-term clinical and radiographic outcomes of CCK in rTKA. This study retrospectively analyzed the results of a consecutive cohort of patients who underwent revision knee arthroplasty using CCK at our centre from January 2005 to January 2022. In this study, we report the long-term follow-up results and survival rate of CCK in rTKA.

Materials and methods

Materials

This was a retrospective review of prospectively collected data from consecutive patients undergoing rTKA with CCK. We obtained data from the joint arthroplasty registry at our hospital from January 2005 to January 2022. The inclusion criteria were as follows: (1) all patients who previously underwent TKA or UKA and underwent revision surgery this time; (2) patients with more than one year follow-up and detailed information. The exclusion criteria were as follows: (1) patients who underwent rTKA using non-CCK prostheses; (2) patients undergoing rTKA due to periprosthetic fractures; (3) patients who refused to enroll or were lost to follow-up. A total of 60 consecutive patients (61 knees) underwent rTKA using CCK in our hospital between January 2005 and January 2022. Five patients (five knees) were lost during follow-up and one patient (one knee) underwent rTKA due to periprosthetic fracture, leaving 54 patients (55 knees) for evaluation. This group consisted of 38 (7.03%) women and 16 (29.6%) men. The mean age was 66 years (range 22–80 years). According to intraoperative evaluation, five patients underwent only femoral prosthesis revision, and two patients underwent only tibial prosthesis revision. Diagnoses triggering primary TKA were degenerative osteoarthritis (48 knees, 87.3%), rheumatoid arthritis (five knees, 9.1%), and hemophilic arthritis (two knees, 3.6%). The causes of rTKA included periprosthetic infection (32 knees, 58.2%), aseptic loosening (13 knees, 23.6%), polyethylene wear (five knees, 9.1%), instability (three knees, 5.5%) and stiffness (two knees, 3.6%). The mean follow-up was 115.2 months (range 13–216 months). Detailed demographic characteristics of patients are illustrated in Table 1. This study was approved by the Ethics Committee of the Peking Union Medical College Hospital. Written informed consents were obtained from all patients.

Table 1 Demographic data

Gender	
Male	16 (29.6%)
Female	38 (70.3%)
Age (years)	66 ± 11.4 (22–80)
Height (cm)	161.0 ± 6.8 (148–177)
Weight (kg)	69.6 ± 11.4 (45–110)
BMI (kg/m2)	26.9 ± 4.3 (17.8–40.4)
Reasons of primary TKA	
Osteoarthritis	48 (87.3%)
Rheumatoid Arthritis	5 (9.1%)
Hemophilic arthritis	2 (3.6%)
Reasons of revision TKA	
Infect	32 (58.2%)
aseptic loosening	13 (23.6%)
Polyethylene wear	5 (9.1%)
Knee joint instability	3 (5.5%)
Knee flexion contracture	2 (3.6%)
Follow-up time (months)	115.2 (13–216)

BMI body mass index, *TKA* total knee arthroplasty

Surgical procedures and implant features

All cases underwent rTKA under general anaesthesia. One-stage surgeries were performed for non-infected knees, and two-stage surgeries were performed for infected knees [17]. The two-stage surgeries included the removal of the primary prosthesis and the insertion of cement spacers in the first stage. Intravenous antibiotics were administered after the first-stage surgery to control the infection. Until the infection was under control, the second-stage surgery was conducted, involving the removal of the cement spacer and the implantation of CCK. Prophylactic antibiotics were administered before any surgery, just before making the incision, and a tourniquet set at 250 mmHg pressure was applied during the procedure to aid in hemostasis. The midline incision of the knee and the standard parapatellar medial approach were selected. If only one side of the prosthesis was loose, revision was carried out only on the femoral or tibial side. Thorough cleaning of the synovial membrane and removal of osteophytes within the knee were performed. Extension and flexion gaps were carefully examined, and soft tissue release was done to achieve varus/valgus balance. After assessment of the stability of the knee, we decided to repair bone defects with cement, autologous/allogeneic cancellous bone grafts, augments, tantalum cones, or metal sleeves. Finally, a CCK with the appropriate size was implanted. In this study, the technique for component fixation was hybrid fixation which involves press-fit stem with cement fixation in the metaphyseal and epiphyseal zones. The lengths of the stems were from 100 to 160 mm. The patella was not replaced in all cases. A drainage tube was placed after the operation.

According to the assessment of bone defects, bone grafts, augments, and metal sleeves were needed in one case, 26 cases, and two cases, respectively. Tantalum cone was necessary in one case.

On the POD1, the patients could use a walker for mobility and began continuous passive motion exercises. Antibiotics were continued for one to two weeks post-surgery based on sensitivity for periprosthetic infection. Drainage tubes were typically removed within 24–48 h after the surgery. Within the initial two weeks post-surgery, low-molecular-weight heparin or rivaroxaban was administered to prevent venous thromboembolism. All patients were monitored after surgery and regularly discharged to rehabilitation centers between PODs 3 and 5.

Follow-up

Outpatient follow-up was scheduled for PODs 30 and 90, and followed by yearly appointments. The operation time and blood transfusion rate were recorded. Postoperative complications such as periprosthetic infection, wound complications, pulmonary embolism, symptomatic DVT, periprosthetic fractures, and perioperative cardiovascular and cerebrovascular events were recorded. Additionally, HCT before surgery and on PODs three were documented to calculate the perioperative blood loss [18, 19]. The visual analogue score (VAS), American Knee Society Score (KSS), Hospital for Special Surgery score (HSS), the Western Ontario and McMaster University Osteoarthritis Index (WOMAC), the Oxford Knee Score (OKS), and range of motion (ROM) were recorded before surgery and at each follow-up to evaluate the clinical effects of surgery. For patients who died, the knees' function and patient-reported outcomes at the last follow-up before death were recorded.

Standard anteroposterior, lateral, skyline, and long-standing AP radiographs of the lower limbs were conducted to assess limb alignment, radiolucent lines, instability, and polyethylene wear. The radiolucent lines of the femoral and tibial prostheses were evaluated according to the 2015 version of the American Knee Society Roentgenographic Evaluation system[20].

Statistical analysis

Statistical analysis was performed by the SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Normal distribution was assessed by the Shapiro–Wilk test. Paired *t*-student tests were used to compare preoperative and postoperative data. CCK prosthesis survival analysis was assessed by the Kaplan–Meier method. A two-tailed $P < 0.05$ was considered to indicate statistical significance. Our datas are represented as the mean ± standard deviation.

Results

Clinical outcomes

The range of motion (ROM) was 82.7 ± 26.1° preoperatively and improved to 108.4 ± 11.8° at the final follow-up. Preoperatively, the HSS, KSKS, and KSFS scores were 45.0 ± 10.4, 38.4 ± 12.1, and 19.6 ± 12.9, respectively, and these scores increased to 85.3 ± 8.6, 88.5 ± 12.0, and 68.8 ± 15.1 at the final follow-up evaluation. Additionally, WOMAC and OKS were 67.9 ± 12.5 and 9.9 ± 4.2, respectively, before the operation and improved to 14.4 ± 9.5 and 41.6 ± 7.7 at the final follow-up. The clinical outcomes, including ROM, HSS, KSS, WOMAC, and OKS, showed significant improvement after revision TKA at the final follow-up evaluation ($P < 0.001$). The detailed results can be found in Table 2.

Table 2 Clinical and imaging results

	Preoperative	Last follow-up	*P*
ROM	82.7 ± 26.1 (20–130)	108.4 ± 11.8 (80–125)	< 0.001
VAS	8.0 ± 1.1 (6–10)	1.3 ± 1.4 (0–5)	< 0.001
HKA	174.2 ± 5.6 (164–188)	179.3 ± 1.2 (177–182)	< 0.001
HSS	45.0 ± 10.4 (21–57)	85.3 ± 8.6 (64–97)	< 0.001
KSKS	38.4 ± 12.1 (0–55)	88.5 ± 12.0 (50–100)	< 0.001
KSFS	19.6 ± 12.9 (0–50)	68.8 ± 15.1 (50–100)	< 0.001
WOMAC	67.9 ± 12.5 (40–90)	14.4 ± 9.5 (5–55)	< 0.001
OKS	9.9 ± 4.2 (2–18)	41.6 ± 7.7 (18–60)	< 0.001

ROM range of motion, *VAS*, visual analog score, *HKA* hip-knee-angle, *HSS* hospital for special surgery score, *KSKS* knee society knee score, *KSFS* knee society function score, *WOMAC* the Western Ontario and McMaster University Osteoarthritis Index, *OKS* oxford knee score

Radiographic outcomes

The preoperative and postoperative mean HKAs were 174.2 ± 5.6 (range 164–188) degrees and 179.3 ± 1.2 (range 177–182) degrees, respectively. During follow-up, radiolucent lines were observed in 26 knees (47.3%), but none of them presented progressive radiolucent lines (Fig. 1). Twelve radiolucent lines were observed around the femoral prosthesis (22.6%), and 17 radiolucent lines were around the tibial prosthesis (34%). On the femoral side, radiolucent lines were present in zone three of one knee, the others were around the stem (zones 4–5), according to KSRES 2015. In tibia, radiolucent lines were seen around the fixation post (zone 3) of five knees, and the extension stem (zones 4–5) of 12 knees. In the final follow-up, no imaging complications such as prosthetic loosening, polyethylene wear, and periprosthetic fractures were found.

Complications

The mean tourniquet time was 149 ± 56.2 minutes. The mean total blood loss was 973.6 ± 421.6 ml (110–1970 ml), and a total of 22 patients (40%) received blood transfusion. There was no case had showed wound complication, symptomatic VTE, or cardiocerebral accidents during the perioperative period. Details are shown in Table 3.

Aseptic loosening or periprosthetic fracture was not observed during the follow-up period. Postoperative complications included five periprosthetic infections (PJI). One case of infections occurred two months after surgery, and the other four cases occurred after more than one year after surgery. After 12 months of surgery, one infected case underwent knee debridement. One case was re-revised for PJI at two years postoperatively and reported good knee function at the last follow-up. The other infected patients were treated with intravenous antibiotics, and no more invasive procedures were performed, resulting in bad function at the last follow-up (KSKS: 40, 40, and 45, respectively).

The rate of survival at 9.6 years was 96% (95% CI, 90.5 to 100%) with reoperation for any reason as the endpoint, and 98% (95% CI, 94.01 to 100%) with re-revision for any reason as the endpoint (Fig. 2–3).

Discussion

High restriction will lead to increased stress on the contact surface between the prosthesis and bone, which in turn will lead to increased polyethylene wear. So far, lots of studies have reported the prosthesis survival rate of CCK used in rTKA. Kunze et al. [21] compared the re-revision rates of PS and CCK prostheses in rTKA and found that PS prostheses had a lower risk of re-revision at a minimum follow-up of 2 years (OR 0.3, $P < 0.001$). Several studies have reported

Fig. 1 A 69-year-old woman underwent rTKA by a CCK prosthesis for polyethylene wear. Hybrid fixation was used, and the femoral and tibial stems were both 100 mm. Non-progressive radiolucent line had been observed during follow-up duration. (A) The polyethylene was worn in ten years after primary TKA. (B) The X-ray after 1 year of the operation showed radiolucent line around the stem of tibial component. (C) The X-ray after 8 years of the operation showed no progression of this radiolucent line around tibial component

Table 3 Complications

Perioperative blood transfusion rate	40.0%
Total blood loss (ml)	973.6 ± 421.6 ml(110–1970 ml)
Postoperative complications	
Periprosthetic infection	5
Aseptic loosening	0
Periprosthetic fracture	0
Symptomatic VTE	0
Perioperative cardiocerebral accidents	0
Total	5

VTE venous thrombosis embolism

the mid- to long-term results of CCK prosthesis in rTKA, with a survival rate of approximately 90% [22, 23]. CCK and RHK are currently the two most widely used prostheses in rTKA, but clinical results are still highly controversial. In a follow-up study with an average of 3.7 years by Barnoud et al. [24], CCK had fewer complications and a higher prosthesis survival rate than RHK (100% vs 77.8%) in rTKA for mechanical failure. Recently, a meta-analysis by Yoon et al. [9] reported that there was no significant difference in ROM and complication rates between the two types of prostheses, while the functional score and mid-term prosthetic survival rate of the CCK group (83.8% vs 81.3%) is slightly better than the RHK group. Recently, CCK prostheses have been increasingly used in primary TKA. Theil et al. [25] compared the 15-year survival rate of CCK prosthesis in primary TKA and rTKA. Although the results of both groups were satisfactory, the survival rate in rTKA (76%) was significantly worse than that in primary TKA (100%). In this study, the 10-year no-revision survival rate of CCK prosthesis used for rTKA was 98.0%. This result seems to be better than the results of all relevant studies so far. Possible reasons we think include (1) the cases in this group were older and had less activity after surgery; (2) we used two-stage revision for infected cases to reduce the reinfection rate; (3) we used 100–160 mm stems with hybrid fixation; (4) we select appropriate materials to repair bone defects based on stability assessment.

This study proves that CCK prosthesis in rTKA is successful in improving knee function, including ROM, HSS score, KSS score, WOMAC score, and OKS score during an average 9.6-year follow-up, which is consistent with the conclusions of previous studies [23, 26]. Compared with previous studies, this group of patients was slightly better than previous studies in terms of local functions such as ROM and KSS, but slightly inferior in terms of systemic functions in patients with responses such as KSFS and OKS. We consider that standardized postoperative rehabilitation training [27], early passive mobilization and ambulation are reasons for better knee function, and the older age may explain the poor systemic function of the patient at the last follow-up. While considering surgical safety, the operation time, perioperative bleeding, and blood transfusion rate of CCK-rTKA are all higher than those of primary TKA [28] but are acceptable for rTKA[21, 29].

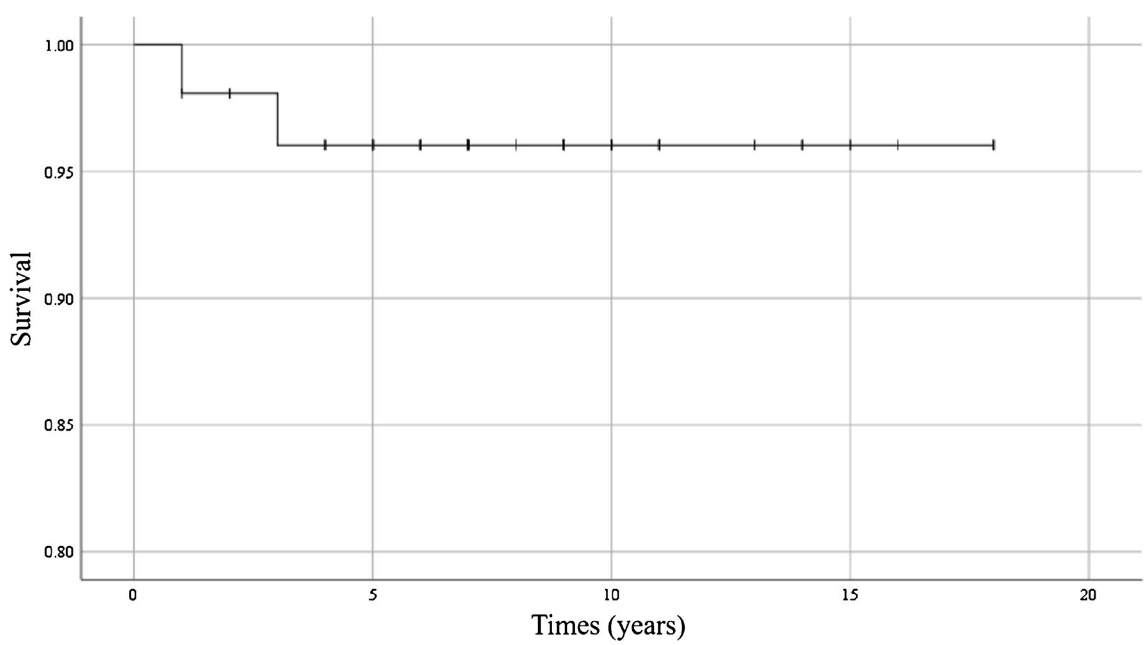

Fig. 2 Survival curve at 9.6 years with reoperation for any reason as the end point

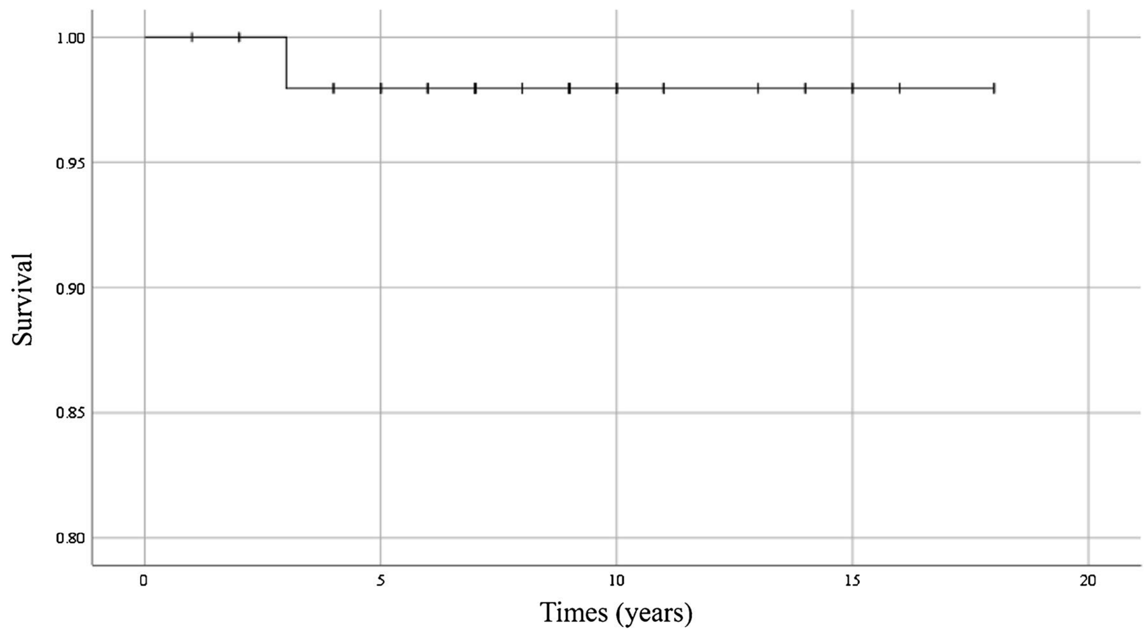

Fig. 3 Survival curve at 9.6 years with re-revision for any reason as the end point

The only reason for reoperation in this group was periprosthetic infection (58.2%). Luque et al. [30] also believed that infection was the main cause of failure of CCK-rTKA (16 cases, 37.2%). However, in the studies of Kim, Pablo et al. [14, 31], the risk of aseptic loosening was higher. Lee et al. [32] pointed out that the postoperative infection rate of septic revision TKA was higher than that of aseptic revision TKA. Shichman et al. [33] reported 90 cases of reinfection after revision surgery for infection, and they noted that the average time to reinfection after rTKA was 21.3 months, the most common pathogen was coagulase-negative staphylococci (31%), and the infection control rate was very low in patients without long-term antibiotic treatment (15.9%). This group of patients had a higher rate of infection and less activity after primary TKA, which may be the reason for the high incidence of reinfection and low aseptic loosening rate in follow-up. In this study, three patients with postoperative infection received long-term intravenous antibiotic treatment, and all reported poor knee function at the last follow-up (KSS scores of 26, 28, and 29, respectively), but they refused to undergo debridement or revision surgery.

The stems can reduce the stress on the metaphyseal and provide more prosthesis fixation surface, which is essential for the fixation of prosthesis [34]. It has been reported that the use of stems can significantly reduce the rate of re-revision in the revision TKA [35]. In this study, all CCK prostheses used stems with a length of 100–160 mm to disperse the stress, hoping to get better fixation and reduce the incidence of aseptic loosening [36]. At the last follow-up, no aseptic loosening or periprosthetic fracture was observed in this group, which is consistent with the results of Ye et al. [37] Limberg et al. [22] reported that rTKA without the use of stems had an increased risk of re-revision. LaMonica et al. [38] demonstrated that the stress on the tibial plateau decreases as the length of the stems increase, while the stem of 100 mm can significantly reduce the stress on the tibial plateau. Meanwhile, Bernardo et al. [39] pointed out that longer stems (280 mm) may cause more pain and stress shielding through biomechanical analysis. According to the results of this and previous studies [40], we believe that the application of 100–160 mm stems with CCK prostheses in rTKA can reduce the incidence of aseptic loosening and is effective and safe.

Revision total knee arthroplasties are usually accompanied by bone defects. In this study, 15 knees were repaired on the single femoral side, three knees were repaired on the single tibial side, and six knees were repaired on the femoral and tibial sides, because of bone defects. Through subgroup analysis at the last follow-up, we found that compared with knees without repair, repairing bone defects did not affect the survival rate of the prosthesis, but the postoperative ROM in the group without bone defect reconstruction was significantly better than the reconstruction group (Table 4). This may be related to the fact that patients undergoing bone defect reconstruction were more difficult to operate and suffered greater intraoperative injuries. However, both groups achieved satisfactory improvements compared with preoperative procedures, so we believe that this difference was not clinically significant. Lai et al. [41] compared the two year

Table 4 Subgroup analysis of bone defect reconstruction

		Reconstruction group	Non-reconstruction group	*P*
ROM	Preoperative	81.6 ± 25.0	84.1 ± 27.8	0.554
	Last follow-up	105.3 ± 13.2	112.2 ± 8.6	0.017
VAS	Preoperative	8.3 ± 1.1	7.7 ± 1.0	0.313
	Last follow-up	1.5 ± 1.5	1.09 ± 1.2	0.257
HKA	Preoperative	175.0 ± 6.2	173.0 ± 4.6	0.530
	Last follow-up	179.7 ± 1.0	178.7 ± 1.3	0.195
HSS	Preoperative	44.2 ± 10.2	46.1 ± 10.9	0.883
	Last follow-up	84.0 ± 9.0	86.9 ± 8.0	0.358
KSKS	Preoperative	37.7 ± 12.2	39.8 ± 12.0	0.742
	Last follow-up	86.9 ± 12.0	90.6 ± 12.1	0.459
KSFS	Preoperative	20.4 ± 13.1	18.6 ± 12.7	0.852
	Last follow-up	69.3 ± 15.2	68.0 ± 15.4	0.806
WOMAC	Preoperative	69.7 ± 12.3	65.7 ± 12.6	0.350
	Last follow-up	16.0 ± 11.5	12.4 ± 5.7	0.187
OKS	Preoperative	9.5 ± 4.3	10.4 ± 4.2	0.934
	Last follow-up	41.5 ± 8.0	41.7 ± 7.0	0.783

ROM range of motion, *VAS* visual analog score, *HKA* hip-knee-angle, *HSS* hospital for special surgery score, *KSKS* knee society knee score, *KSFS* knee society function score, *WOMAC* the Western Ontario and McMaster University Osteoarthritis Index, *OKS* oxford knee score

clinical results of rTKA with CCK prosthesis with or without a metal sleeve and reported that there was no significant difference in ROM and KSS scores between the two groups. There is still controversy as to whether bone defect repair will lead to a decrease in ROM after rTKA, and which bone defect repair method is more conducive to the recovery of knee function. Because there were too few samples for subgroup analysis of different repair methods, this issue may require further exploration in the future.

The optimal fixation technique for CCK prostheses with stems remains controversial. In the primary TKA, Daffara et al. [42] reported that there is no significant difference in early survival rate between cement or cementless prostheses. But in revision TKA, the use of cement at the proximal components is widely accepted [43–45]. However, since full cementation may lead to potential stress shielding and difficulty in removing the cement during re-revision [46], it is still unclear whether to use cement to fix the stem. Kwon et al. [43] reported 18 cases of CCK-rTKA fixed by full cementation, and no instability or aseptic loosening was observed during the seven year follow-up. Laudren et al. [44] compared the seven year follow-up results of full cementation and hybrid fixation technology for CCK-rTKA, and reported that there was no significant difference in clinical results between the two groups, but the full cementation group got better imaging results. Song et al. [45] universally employed full cement fixation for femoral prostheses in 37 patients who received re-revision TKA due to aseptic loosening with femoral diaphyseal deformation and no instances of aseptic loosening were observed over a mean follow-up of ten years. Nevertheless, the authors advised exercising caution in utilizing full cementation for patients undergoing revision TKA with infection due to the elevated risk of reinfection. In this study, infection is the main cause of revision and deformities were mainly in the metaphysis. In this study, we used the hybrid fixation technique, which involves press-fit stem with cement fixation in proximal components. Although radiolucent lines were observed around 47.3% of knees, no aseptic loosening occurred at the last follow-up. We think this fixation method in CCK-rTKA is reliable.

The advantage of this study is that it reports the clinical and radiographic results and long-term survival rate of CCK-rTKA. As the revision rate of TKA increasing, CCK prostheses are used more and more widely and frequently. The results of this study support the application of CCK prostheses in rTKA. However, this study also has limitations. First, this is a retrospective study with relatively few cases and a short follow-up period. We did not conduct randomized clinical trials or compare this prosthesis with other prostheses. Secondly, only one patient underwent re-revision surgery, so subgroup analysis of the risk of re-revision cannot be performed. As the sample increases, subgroup analysis can be performed in the future to explore the risk factors of re-revision. Finally, although the surgical techniques were almost identical, the surgeons were not the same.

Conclusion

In this study, infection is the most common postoperative complication and the main reason for failure of rTKA. During a mean 9.6-year follow-up, the application of CCK prosthesis in rTKA provided good function and implant survival while ensuring surgical safety.

Author contribution All the authors participated in the design, performance, analysis, and drafting of this manuscript.

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Data availability The datasets used or analyzed during the current study are available from the corresponding author on reasonable request.

Code availability Not applicable.

Declarations

Ethics approval Ethical approval was granted from the ethics committee of the institution.

Informed consent A written consent was taken from all participants as per department protocol. A signed written consent was obtained from all participants for the use and publication of all personal data including personal Xrays.

Conflict of interest The authors declare no competing interests.

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