



Long-term results of porous-coated cementless total knee arthroplasty with screw fixation

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Objective: The aim of this study was to evaluate the long-term results of porous-coated, cementless total knee arthroplasty with screw fixation.

Methods: This study included 68 knees of 54 patients (43 female, 11 male; mean age: 56.9 years, range 46 to 70 years). Cruciate-retaining cementless total knee prostheses were implanted in all patients diagnosed with primary osteoarthritis. Clinical, functional and radiological evaluations were performed according to the Knee Society's Knee Scoring System (KSS). Prosthesis survival was analyzed using Kaplan-Meier curves. Mean follow-up time was 9.2 (range: 8 to 12) years.

Results: Preoperative mean knee and function scores were 42.3 (range: 32 to 61) and 39.1 (range: 35 to 66), respectively, while they were 88.6 (range: 54 to 96) and 82.8 (range: 50 to 100), respectively at the final follow-up ($p<0.05$). Mean preoperative knee flexion was 98° (range: 80° to 110°) and 112° (range: 85° to 130°) at the final follow-up ($p<0.05$). Preoperative and postoperative mean alignments were 9.2° varus and 5.4° valgus, respectively. Revisions were performed due to aseptic loosening of the tibial component in one patient, periprosthetic fracture in one and dislocation of the patella in one. Two superficial infections (3%) were observed. There was no osteolysis around the screws during the follow-up period. The overall rate of implant survival was 95.6% (range: 91.56% to 99.60%; 95% CI) at 12 years.

Conclusion: Long-term outcomes of porous-coated, cementless total knee arthroplasty with screw fixation were successful in terms of clinical and radiological evaluation and yielded a high survival rate.

Key words: Arthroplasty; cementless total knee arthroplasty; osteoarthritis; porous-coated; prosthesis; screw fixation.

Total knee arthroplasty (TKA) is a procedure with a high level of patient satisfaction in end-stage degenerative and inflammatory joint diseases where conservative treatment has failed.^[1,2]

Recent years have brought about an increase in the number of revisions due to a gradual decrease in the age at which TKA is performed^[3] and increase in the

mean human lifespan.^[4] Total knee arthroplasty treatment aims include pain relief, increasing the knee range of motion, achieving good joint alignment and long-term stability with reliable prosthesis fixation.^[5] Cemented implants initially provide a more reliable stable fixation.^[6] However, questions have been raised about the long-term durability of cemented fixation as

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cement has a weak resistance to tension and shear forces and may deform and degrade over the years,^[7] as well as the high rate of osteolysis related loosening observed at the cement bone interface in young and active patients.^[8]

Cementless fixation was begun to be used in the knee arthroplasty due to laboratory and clinical studies showing the importance of biologic bone ingrowth for more stable bone-implant interface on the durability of component fixation.^[9,10] However, failures were observed mainly due to osteolysis with first designs of cementless prostheses,^[11] lessening the number of cementless prostheses performed. Nevertheless, in parallel to recent advances in prosthesis designs and implant technology, cementless prostheses became more common.^[5,12] Currently, it is debated whether cementless prostheses can be an alternative to the gold standard cemented prostheses.^[5,10,12]

In this study, we aimed to evaluate the long-term results of porous-coated, cementless TKA with screw fixation.

Patients and methods

Available records of 68 knees of 54 patients (43 female, 11 male) who underwent cementless TKA for primary knee osteoarthritis between January 2001 and March 2005 were retrospectively evaluated. Mean age at the time of operation was 56.9 (range: 46 to 70) years (Table 1).

Inclusion criteria were persistent knee pain not responsive to conservative treatment, degenerative knee osteoarthritis (Ahlbäck Grade 4-5),^[13] precise femoral and tibial bone cuts, good bone quality or good component fixation. All patients meeting these criteria were treated with cruciate-retaining, cementless total knee prostheses (Performance Total Knee System; Biomet, Inc., Warsaw, IN, USA). Patients with active infection in any part of the body, inflammatory knee arthritis, hip osteoarthritis causing hip pain and limitation of motion, foot and ankle disorders that limit walking, and dementia were excluded from the study.

Table 1. Demographic data of the patients.

Parameter	Value
Male/female ratio (no. of patients)	43/11
Right/left ratio (no. of knees)	38/30
Height in cm (range)	160 (155-168)
Weight in kg (range)	82 (62-86)
Mean age in years (range)	57.2 (46-70)
Mean follow-up time in years (range)	9.2 (8-12)

First generation cephalosporin was used for antibiotic prophylaxis for 48 to 72 hours after the surgery. For venous thromboembolism prophylaxis, 2850 IU of nadroparin was administered daily to all patients for 10 days.

Operations were performed under spinal or epidural anesthesia. After applying the tourniquet, the medial parapatellar arthrotomy, following a midline longitudinal skin incision, was used for all patients. Femoral cuts were made first. As the quality of bone decreases when moving from proximal to distal, tibial bone cuts were made as proximal as possible. In order to protect bone surface viability, bone surfaces were cooled with normal saline.

After the cuts were completed, the presence of depression was evaluated by pressing the thumb on the tibia in order to evaluate bone quality. A cemented prosthesis was used in cases where depression was observed in the tibia. Trial components were inserted and the stability of components manually checked in full flexion and extension and upon application of varus and valgus stress. Cementless prosthesis was then implanted. The tibial component had a porous-coated titanium alloy Ti 6Al-4V ELI (extra-low interstitial) ASTM F136, and femoral components had a porous-coated chrome-cobalt alloy (Fig. 1). Tibial fixation was enhanced with a large central keel and four cancellous screws. The tibial insert was screwed to the baseplate using the central hole. Thus, compression was achieved between the tibial insert and baseplate.

In Outerbridge^[14] Grade 3 and 4 cases, the patellar surface was replaced. Hemostasis was obtained and the wound was closed. The aspirating drainage tube was removed within 24 to 48 hours.

Patients were allowed isometric quadriceps exercises and partial weight-bearing on the first postoperative day. Full weight-bearing was allowed after 6 weeks. Mean follow-up time was 9.2 (range: 8 to 12) years.

Preoperative patient assessment was undertaken with routine laboratory study, physical examination and standard forms. Postoperative follow-up was made at the sixth week, third and sixth months, first year and at every second year following the operation using a clinical knee score based on the Knee Society's Knee Scoring System (KSS).^[15]

Radiographic outcome measurement was based on the Knee Society radiographic evaluation and scoring system.^[16] Standing anteroposterior (AP), lateral and skyline patellar radiographs were taken both pre- and postoperatively.

Detailed radiographic analysis of subsidence was performed with an additional emphasis on the prosthe-

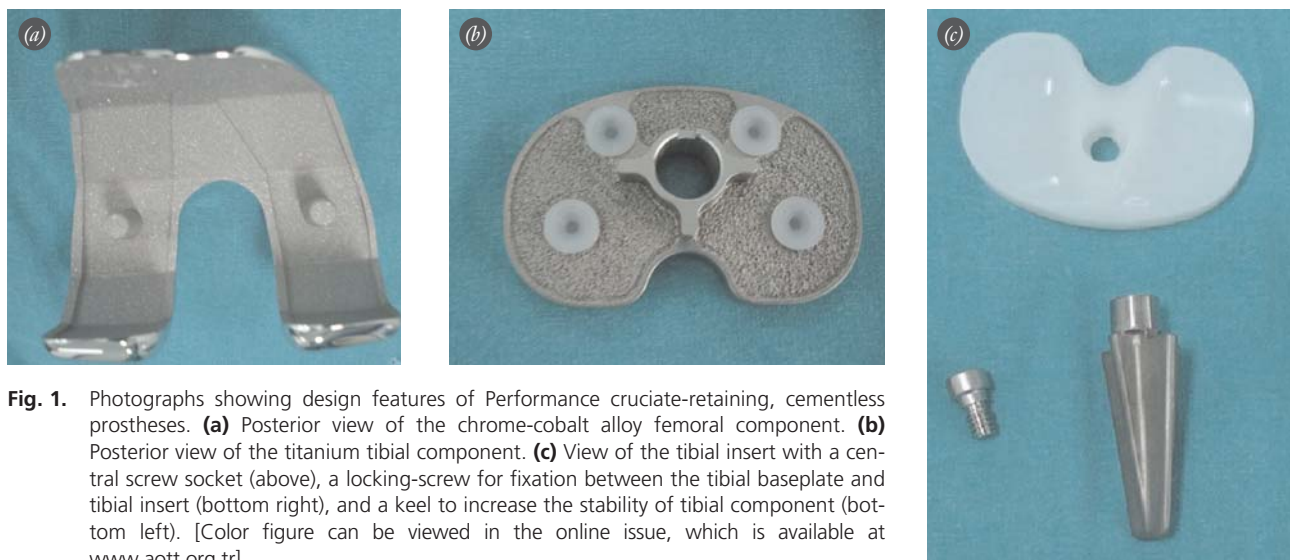


Fig. 1. Photographs showing design features of Performance cruciate-retaining, cementless prostheses. **(a)** Posterior view of the chrome-cobalt alloy femoral component. **(b)** Posterior view of the titanium tibial component. **(c)** View of the tibial insert with a central screw socket (above), a locking-screw for fixation between the tibial baseplate and tibial insert (bottom right), and a keel to increase the stability of tibial component (bottom left). [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

sis-bone interface for radiolucencies, sclerotic halo lines and evidence of osseointegration. Radiolucent lines (RLLs) were measured in millimeters (mm) for each zone to evaluate bone-prosthesis interface, fixation quality and signs of loosening.^[16]

Pre- and postoperative knee and function scores were compared using a paired t-test on SPSS 15.0 for Windows (SPSS Inc, Chicago, IL, USA). P values of less than 0.05 were considered significant. Prosthesis survival was analyzed using Kaplan-Meier curves.^[17] According to this analysis, revision surgery for instability, septic or aseptic loosening and fracture of the tibia, femur or patella were accepted as failure.

Results

Knee Scoring System results were excellent in 24 knees (35.3%), good in 32 knees (47%), fair in 11 knees (16.2%), and poor in one knee (1.5%). The mean knee flexion increased from a preoperative 98 (range: 80 to 110) degrees to 112 (range: 85 to 130) degrees at the latest follow-up. Both these improvements were significant ($p < 0.05$) (Table 2).

All cases experienced severe preoperative pain. Postoperatively, 48 knees (70.6%) had no pain, 15 (22%) mild pain, four (5.9%) moderate pain, and one (1.5%) severe pain. Of the 68 knees, 22 knees (32%)

were operated on when the patients were under the age of 55 years. No significant difference in mean clinical score and range of motion was found in this subgroup ($p > 0.05$).

Patellar resurfacing was performed in 44 knees (65%). Anterior knee pain was observed in 4 knees in the patella replaced group (9%) and in 2 knees in the non-replaced group (8%). In these cases, conservative treatment was used initially. However, 2 patients without patellar replacement experienced severe anterior knee pain and 2 patellae were resurfaced after a mean of 24 (range: 18 to 30) months. Further surgery was required more often in the patella non-resurfaced group than in resurfaced group.

The mean thickness of the tibial polyethylene insert was 10 (range: 8 to 12) mm. Mean tourniquet time was 52 (range: 45 to 95) minutes.

Preoperative mean varus was 9.2° (range: 3° valgus to 17° varus) and postoperative mean alignment was 5.4° valgus (range: 3° varus to 10° valgus). RLLs less than 2 mm in width were present in eleven knees (16%) although no progression was observed in these RLLs (Table 3). A progressive RLL of more than 2 mm in width was seen in tibia Zone 1 in one case. A small RLL was observed around a screw in 2 cases. Osteolysis around the screws or the medial or lateral compartment space asymmetry suggestive of tibial polyethylene wear were not observed in any case. Solid fixation of components was demonstrated by radiographic evidence of the trabecular bone extending onto the implant surface (Fig. 2).

Superficial infection developed in two knees (3%) in the early postoperative period. Both knees were

Table 2. The mean preoperative and latest follow-up knee and functional scores using the KSS.

	Preoperative	Latest follow-up
Mean knee score (range)	42.3 (32-61)	88.6 (54-96)
Mean functional score (range)	39.1 (35-66)	82.8 (50-100)

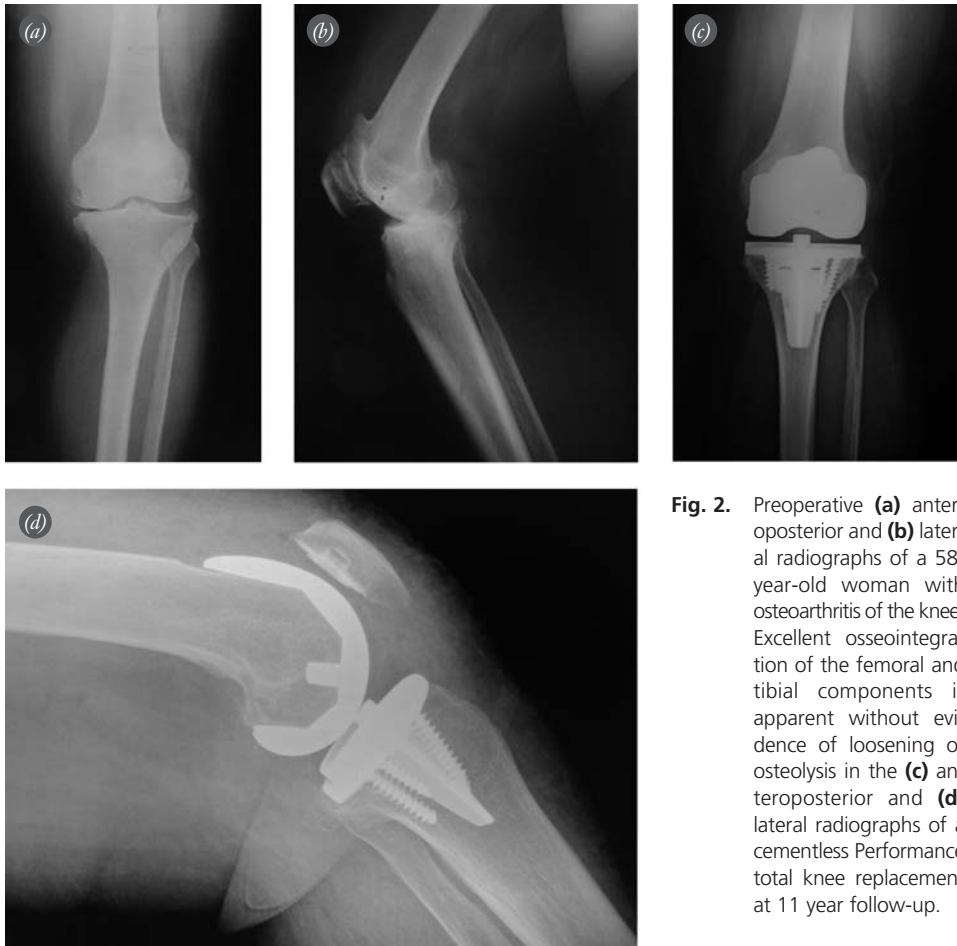


Fig. 2. Preoperative **(a)** anteroposterior and **(b)** lateral radiographs of a 58-year-old woman with osteoarthritis of the knee. Excellent osseointegration of the femoral and tibial components is apparent without evidence of loosening or osteolysis in the **(c)** anteroposterior and **(d)** lateral radiographs of a cementless Performance total knee replacement at 11 year follow-up.

treated with wound care and antibiotherapy. No patients developed deep infections. There was no nerve palsy, vascular injury, or dislocation in any of the patients (Table 4).

Aseptic loosening was observed in the tibial component in one patient (1.5%). Revision was performed in the 20th month and the tibial component was revised without bone loss. As the femoral component was securely fixed to the bone, it was not replaced. In another patient, periprosthetic femur fracture occurred at the 28th postoperative month. The fracture was treated with closed retrograde femoral nailing and union was obtained. Patellofemoral dislocation was seen in one patient who was treated with lateral release, medial plication and medialization of the tibial tuberosity. The range of knee motion was less than 90 degrees in this patient.

The Kaplan-Meier survival rate was 95.6% (range: 91.56% to 99.60%; 95% CI) at 12 years (Fig. 3). Excluding patients with periprosthetic femur fracture and patellofemoral instability, survival rates were

100% for the femoral component and 98.5% for the tibial component at 12 years.

Discussion

The ideal component fixation for TKA continues to be debated, with cemented fixation commonly preferred.^[1,2] Total knee arthroplasty has gradually become more common in young and active patients.^[3,4,12] However, degradation of cement^[7] and third-body wear^[8] with time can result in osteolysis, leading to greater risk of loosening,^[4,8] thus giving rise to questions about the success and long-term survival of cemented prostheses. Cementless prostheses providing biological fixation by means of bone ingrowth has been developed to solve this problem.^[5,9,10,12]

Cementless knee prostheses have several advantages, including; biological integration of the prosthesis to the bone to improve its survival, minimization of bone loss when revision is required, lowering the risk of infection by decreasing the operation time, prevention of third-body wear caused by cement, and easier

Table 3. The radiological results of 68 knees of 54 patients using the Knee Society's radiological scoring system.

Mean alignment in degrees (range)	
Preoperative	9.2 varus (3 valgus-17 varus)
Postoperative	5.4 valgus (3 varus-10 valgus)
Mean femoral component position (femoral angle in degrees) (range)	
Frontal	96 (95-97)
Lateral	2 (0-4)
Tibial component position in degrees (range)	
Frontal	89 (83-93)
Lateral	86 (82-90)
Number of radiolucent lines	
<2 mm on the tibial side (%)	7 (10.3)
<2 mm on the femoral side (%)	4 (6)
>2 mm (%)	1 (1.5)
Posterior condylar offset in mm (range)	
Preoperative	28.9 (26-33)
Postoperative	29.1 (27-34)
Joint line in mm (range)	
Preoperative	17.2 (11-25)
Postoperative	16.7 (12-22)

treatment of periprosthetic fractures when they occur.^[9-11] Disadvantages include the necessity for precise bone cuts, maintenance of primary stability to prevent micromotion and six weeks of non-weight-bearing for bone integration.

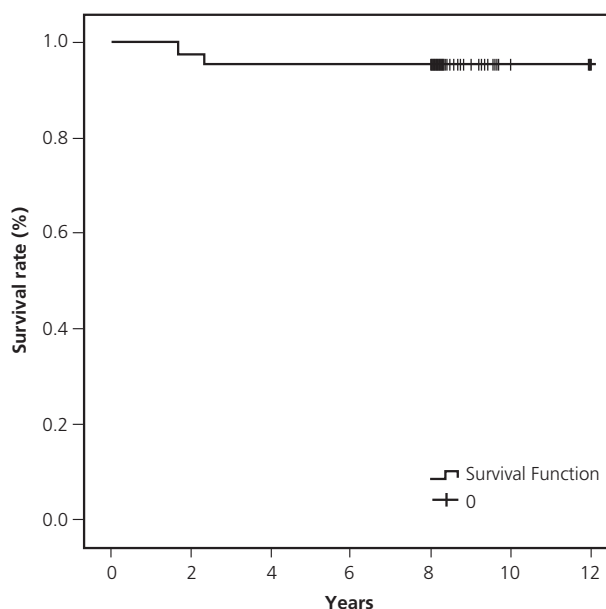
Some failures occurred with the first-generation cementless prostheses, attributed to the low quality of polyethylene,^[18] insufficient fixation of tibial component,^[19] problems with locking mechanism of the tibial insert,^[20] fatigue fracture of the femoral component,^[21] metallosis caused by metal-backed patellar components,^[5] and lack of porous coating on all component surfaces.^[20] Due to these failures, cementless prostheses were not widely used. However, advances in prostheses designs, surgical techniques, polyethylene quality and surface coating technology have led to an increase in interest in cementless knee prostheses.^[5,21-23]

Table 4. Number of complications of cementless total knee replacement (%).

Superficial wound infection	2 (3)
Symptomatic DVT	1 (1.5)
Pneumonia	1 (1.5)
Patellofemoral pain	4 (6)
Pressure sore	1 (1.5)
Total (%)	11 (14.7)

DVT: deep-vein thrombosis

Although cementless TKA has generally been recommended in young and active patients with a long life expectancy,^[12] it has also been used successfully in elderly patients.^[5,12] Whiteside and Viganò^[24] compared the results of cementless prosthesis in young and heavy (<55 years and >90 kg) patients with older and lighter (>65

**Fig. 3.** The Kaplan-Meier survival curve demonstrates 95.6% of implant survival at 12-years.

years and <90 kg) ones. They did not observe loosening in any patients and only one case developed polyethylene wear in the young and heavy group during the 7.3 year follow-up. The authors stated that the use of the osseointegration technique also gives successful results in young and overweight patients. It was suggested that severe osteoporosis impairs implant stability and cementless implants should not be considered in such cases.^[25] In our study, all patients were operated on for primary osteoarthritis. Bone quality and primary stability of the prosthesis were used as criteria for patient selection. Our group of patients can be accepted to be relatively young (mean age: 56.9 years). Of the 68 knees, 22 (32%) were those of over the age of 55 years. The mean KSS scores and range of joint motion were similar between patients aged <55 years and those aged >55 years ($p>0.05$). Therefore, bone quality should be used rather than age in patient selection.

In their cementless TKA series, Whiteside and Viganò reported that knee scores improved from 30 to 89 and function score improved from 46 to 95 after a 10 year follow-up.^[24] Ritter and Meneghini reported that knee score improved from 56 to 91 and function score from 29 to 76 after a 20 year follow-up.^[5] Our results are in concordance with the literature (Table 2).

The mean 10-year survival of cementless prostheses has been reported to be between 92% and 99%.^[5,9,10,22,23] Ritter and Meneghini^[5] reported that none of the 73 cases had loosening of the femoral component and only two tibial components developed aseptic loosening. When excluding problems observed with metal-backed patellae, survival rates of 96.8% were achieved in the tibial component and 100% in the femoral component at the 20 year follow-up. Baker et al. showed similar results in terms of component survival (80.7% and 75.3%, respectively) at 15 years when comparing cementless and cemented TKA despite higher failure rates in males in the cemented group.^[23] Park and Kim^[22] used cemented total knee prosthesis in one knee and cementless total knee prosthesis in the other knee of 50 patients (100 knees) and reported femoral component survival of 100% in both groups and tibial component survival in the cementless and cemented groups of 98% and 100%, respectively. The authors stated that cementless prostheses are as successful as cemented prostheses but could not demonstrate the superiority of cementless prostheses.

Micromotion between the bone-prosthesis interface prevents osseointegration in cementless TKA. Therefore, it is crucial to obtain and maintain component stability. Better stability is achieved through use of cancellous screws for fixation of the tibial component and a central stem, thereby obtaining biological

fixation with bone ingrowth into the prosthesis.^[19] The development of osteolysis in cementless TKA is the most important cause of prosthesis failure.^[11,19] Rates of osteolysis occurring under the tibial component or around the screws have been reported between 0% and 39%.^[11,19,25,26] In a study by Lewis et al.^[26] with a mean follow-up of 4 years, radiolucent zones were observed around 265 of 851 screws, with 185 (21.7%) screws showing cavitory appearance change. The authors suggested that the migration of polyethylene wear products and synovial fluid to the edges of the screws and bone-metal interface through the screw holes contributed to the development of osteolysis. Schepers et al.^[27] compared cementless TKA with screw with cementless TKA without screw fixation and found no difference between both groups in terms of clinical and radiological results after a mean follow-up of 5.6 years. The authors suggested that the use of screws was unnecessary when a large central keel was used. On the other hand, hybrid prostheses consisting of a cementless femoral component and cemented tibial and patellar components have been successfully utilized to avoid failures related to the tibial component fixation.^[28]

In our trial, the 12-year survival rate was 95.6%. Aseptic tibial loosening developed in one case (1.5%). Based on these results, we considered the use of a large central keel with screws to be useful in increasing the stability of the tibial component. In addition, the high quality of polyethylene and its conformity with the femoral component may reduce polyethylene wear. In all cases, the tibial insert was screwed on the tibial baseplate via its central hole and compressed. We suggested that by means of this compression, the micromotion between two surfaces and the amount of polyethylene debris may be reduced; this compression may also prevent distal migration of these products to the tibial metaphysis.

Khaw et al. reported a lower incidence of infections in cementless TKA without establishing a reason.^[29] Whereas Dixon et al.^[30] successfully treated deep infections with arthroscopic debridement in cementless prostheses, similar success could not be achieved with cemented prostheses. They suggested that infection remains limited and treatment becomes easier due to the absence of avascular cement-prosthesis interface in cementless knee prostheses. In our series, no patient developed deep infection. Although the number of patients is not sufficient to interpret this finding, we believe that the shorter operation time may decrease the probability of infection.

Although mid- and long-term cementless and cemented prostheses results are similar, the superiority

of cementless prostheses has yet to be proven.^[22,23,29,31,32]

However, in the light of the literature, cementless prostheses may be preferred in young and active patients with good bone quality in order to obtain biological fixation and improve implant survival.

In conclusion, cementless total knee prostheses with screw fixation achieved long-term satisfactory clinical and radiological outcomes and a high survival rate. The future for cementless prostheses is promising although further time and studies are necessary to determine whether their use will replace that of cemented prostheses in total hip arthroplasty.

Conflicts of Interest: No conflicts declared.

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