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KNEE ARTHROPLASTY

Cementless Oxford medial unicompartimental knee replacement: an independent series with a 5-year-follow-up

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Abstract

Purpose Cemented unicompartmental knee replacement (UKR) has proven excellent long-term survival rates and functional scores in Price et al. (Clin Orthop Relat Res 435:171–180, 2005), Price and Svard (Clin Orthop Relat Res 469(1):174–179, 2011) and Murray et al. (Bone Joint Surg Br 80(6):983–989, 1998). The main causes for revision, aseptic loosening and pain of unknown origin might be addressed by cementless UKR in Liddle et al. (Bone Joint J 95-B(2):181–187, 2013), Pandit et al. (J Bone Joint Surg Am 95(15):1365–1372, 2013), National Joint Registry for England, Wales and Northern Ireland: 10th Annual Report 2013 (http://www.njrcentre.org.uk/njrcentre/Portals/0/Documents/England/Reports/10th_annual_report/NJR%2010th%20Annual%20Report%202013%20B.pdf, 2013), Swedish Knee Arthroplasty Register: Annual Report 2013 (http://www.myknee.se/pdf/SKAR2013_Eng.pdf, 2013).

Methods This single-centre retrospective cohort study reports the 5-year follow-up results of our first 30 consecutively implanted cementless Oxford UKR (OUKR). Clinical outcome was measured using the OKS, AKSS, range of movement and level of pain (visual analogue scale). The results were compared to cemented OUKR in a matched-pair analysis.

Results Implant survival was 89.7%. One revision each was performed due to tibial fracture, progression of osteoarthritis (OA) and inlay dislocation. The 5-year survival rate of the cementless group was 89.7% and of the cemented group 94.1%. Both groups showed excellent postoperative clinical scores.

Conclusions Cementless fixation shows good survival rates and clinical outcome compared to cemented fixation.

Keywords Cementless UKR · Oxford medial · OUKR outcome · Survival · Tibial fracture

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Introduction

According to recent registry data, the use of cemented UKR ranges between 5 and 10% of all knee arthroplasties performed [7–9]. The cemented OUKR proved to be reliable in terms of implant survival as well as functional outcome in trials by both designing centres as well as independent studies [1–3, 10].

Registry data show aseptic loosening of the tibial component and pain as the most common causes for revision in cemented OUKR. Component loosening is often caused by incorrect seating of the implant or micromotion causing a fibrous tissue layer between cement and bone that might inhibit secure fixation [11]. To foster bone ingrowth, the cementless prosthesis is coated with porous titanium and hydroxyapatite, with the aim for permanent biological fixation with excellent clinical results [12].

First studies about cementless OUKR have shown equally good clinical outcome and survival rates compared to the cemented version and higher survival than other cementless implants such as the Alpina prosthesis [4, 5, 13–18].

Nevertheless, there are reports raising concern about tibial plateau fractures and tibial valgus subsidence leading to revision in cementless fixation. Tibial plateau fractures seem to be more common in cementless UKR and they are associated with an extended sagittal saw cut, improper preparation of the tibia and low bone density [19]. Valgus subsidence in cementless OUKR may be caused by laterally implanted femoral components, causing mediolateral micromotion and impingement of the inlay against the medial tibial wall [11, 12].

The purpose of this study was to assess the mid-term clinical results, the survival rates and the complications of the first 30 knees treated consecutively with cementless OUKR at an independent centre. We also compared the clinical results to a cemented collective with a matched pair analysis.

Patients and methods

The institutional review board of the University of Heidelberg approved all procedures (S-546/2013), and the study was conducted in accordance with the Helsinki Declaration of 1964, as revised in 2013. Informed consent was obtained from all individual participants included in the study.

This single-centre cohort study includes the first 30 cementless OUKR implanted in 27 patients consecutively between 2007 and 2009 at our institution. All patients suffered from anteromedial osteoarthritis (AMOA). In all cases, the anterior cruciate ligament (ACL) and collateral ligaments were intact and the varus deformity was manually fully correctable. A previous osteotomy or a flexion deformity >15° was considered contraindications, whereas cartilage loss in the patello-femoral joint, obesity and age were not considered contraindications [20].

Implant design and implantation

The cementless implantation was performed by three orthopaedic consultants experienced in the Oxford Phase III unicompartimental knee prosthesis (Biomet UK Ltd, Swindon, United Kingdom) [21]. A few changes were made by the developing centres to allow cementless implantation: the weight bearing surfaces are coated with calcium hydroxyapatite (HA), and the cement pockets on both components are filled with porous titanium. The cut for the tibial keel is narrower than in the cemented model to ensure a tight press-fit and the cementless prosthesis is implanted in a more flexed knee position, so that the femoral part extends a further 17° anteriorly. The femoral component has two cylindrical HA-coated pegs to impede rotational stress on the implant [4, 5].

For clinical assessment, the range of motion (ROM), Oxford Knee Score (OKS, measured on a scale from 0 to 48 points) and the American Knee Society Score (AKSS) were tested pre- and postoperatively. The pain level was evaluated on a visual analogue scale (VAS). Revision was defined as any surgery with the exchange or removal of at least one part of the implant. Reoperation includes revisions as well as any other surgical procedures. Survival for the endpoints revision and reoperation was calculated using Kaplan–Meier Analysis.

In a matched-pair analysis, implant survival and clinical outcome of the cementless group were compared to a group of 30 patients with cemented OUKR who were implanted at our institution between 2001 and 2009. Patients were matched for sex, age and BMI as well as preoperative OKS score [5, 14].

Statistics

Data were described and analysed using IBM SPSS Statistics 21 (SPSS Inc., Somers, NY). We performed a power analysis to determine the number of patients needed to detect significant differences. As a far higher number of implants per group would be needed, we decided not to perform *t* test analysis. Values will be presented in total numbers or percent in combination with the range, standard deviation, and the 95% confidence interval.

Results

The results of this study are to be interpreted in the context of an early exploratory study. The cementless group consisted of 30 OUKR, implanted in 27 patients (15 male, 12 female). Mean age at surgery was 62.5 years (49–76) and mean follow-up time was 60.0 months (range 47–69; SD 8.3). No patient died or was lost to follow-up. One knee was excluded from the study, since it had not been implanted in accordance with the Oxford manual of surgical technique.

Survival rate

Two knees were excluded from clinical evaluation due to early revision (see Fig. 1). Overall, 5 years after implantation, three knees have undergone revision (see Table 1): There was one case of periprosthetic tibial plateau fracture within the first month after implantation. It was revised to a cemented tibial component and ORIF. The second patient was revised to a total knee replacement due to progressive OA of the lateral compartment and the patello-femoral joint (PFJ) 26 months after implantation. The third revision was due to a mobile-bearing dislocation that occurred 21 months after surgery. The bearing was exchanged to a thicker one. The remaining 27 knees were assessed clinically and radiologically 3 months, 1 and 5 years postoperatively. Additionally, one reoperation was performed due to OA of the PFJ. The patient was provided a femoro-

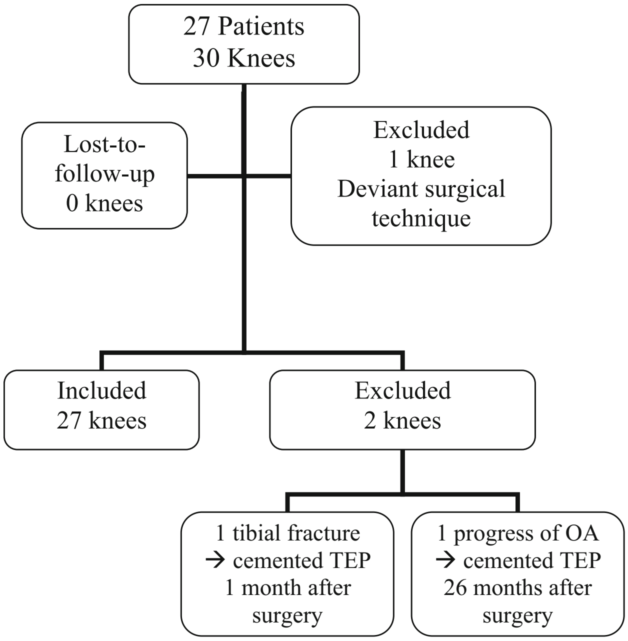

Fig. 1 Patients included in this study

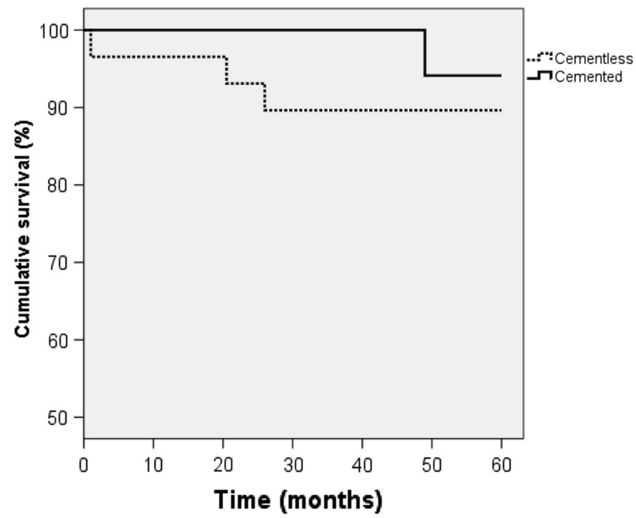

Fig. 2 Implant survival (endpoint: revision for any reason)

patellar arthroplasty in addition to her OUKR without exchanging any of the previously implanted components. There was no tibial or femoral loosening in this study. Five-year survival rate with revision as endpoint was 89.7% (95% CI 0.79–1.0) (see Fig. 2), with reoperation it was 86.2% (95% CI 0.74–0.99). All reoperations occurred within the first 2 years after index surgery.

Clinical outcome

In the cementless group, all clinical and functional variables improved strongly from pre- to postoperative results (see Fig. 3). The mean OKS was 27.2 points (SD 6.4, 95% CI 24.6–29.7) pre-operatively and 42.1 points (SD 7.6, 95% CI 29.1–45.1) postoperatively, with a mean change of 15.0 points (SD 7.9, 95% CI 11.8–18.1). The mean AKSS-O improved from 50.7 before surgery (SD 13.3, 95% CI 45.4–56.0) to 92.7 after surgery (SD 10.7, 95% CI 88.5–96.9), with a mean increase of 42 points (SD 18.5, 95% CI 34.7–49.3).

Matched pair

The matched-pair collective was well matched for age, sex, BMI and preoperative OKS. AKSS-O improved in both groups after surgery, whereby the improvement did not differ more than one point between the groups. The cementless group improved in the pain score more distinct than the cemented group (ΔVAS 6.1 vs. 5.4), while the cemented group showed higher improvement in the ROM (ΔROM 15.1 vs. 8.0) (see Table 2). In the cemented collective, one revision was performed due to a posttraumatic tibial fracture. It was treated with ORIF and TKR. One reoperation had to be performed due to small cement bodies in the joint space. A therapeutic arthroscopy was performed and the cement was removed (see Table 2). The 5-year survival rate with revision as endpoint is 94.1%

Table 1 Revision and additional reoperation

Patient	Point of time post surgery (month)	Cause of revision	Type of procedure	Procedure
Cementless group				
Patient 1	1.0	Tibial plateau fracture	Revision	ORIF + cemented tibial component
Patient 2	20.5	Dislocation of mobile bearing	Revision	Exchange of PE inlay
Patient 3	26.0	PFJ-OA + lat. OA	Revision	TKR
Patient 4	31.2	PFJ-OA	Reoperation	Additional patello-femoral arthroplasty
Cemented group				
Patient 1	48.6	Posttraumatic tibial plateau fracture	Revision	ORIF + TKR
Patient 2	1.0	Loose cement bodies	Reoperation	Therapeutic arthroscopy

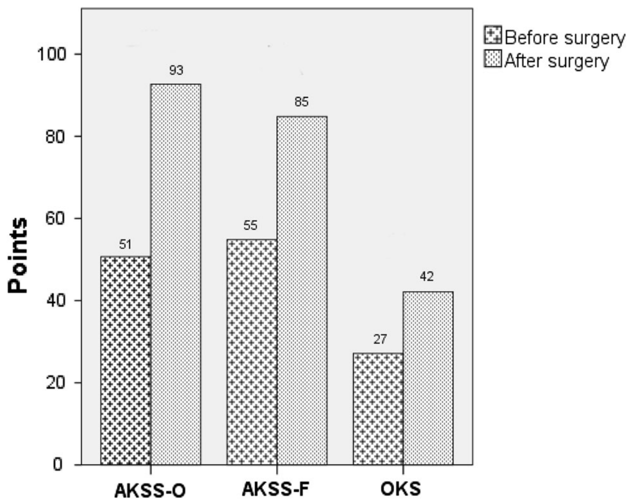

Fig. 3 Improvement of scores 5 years after surgery

(95% CI 0.83–1.0); with reoperation as endpoint, it is 91.0% (95% CI 0.78–1.0).

Discussion

In this independent study, we enrolled the first 30 OUKR (27 patients) implanted consecutively in our hospital. With a mean follow-up of 5 years, we evaluated the clinical outcome using the OKS, AKSS, ROM and level of pain. Outcome and implant survival rate were compared to cemented medial OUKR in a matched-pair analysis.

The findings of our study show good clinical and functional outcome after cementless OUKR compared to cemented fixation. The cemented and the cementless group showed a strong improvement of AKSS-O and OKS-scores [ΔAKSS-O cemented: 41.1 (95% CI 34.6–48.3)]; ΔAKSS-O cementless: 42.0 (95% CI 34.7–49.3); ΔOKS cemented and cementless: 15.0, (95% CI cementless: 95% CI 11.8–18.1; 95% CI cemented: 11.6–18.5). Our findings are in line with prospective randomized studies comparing cemented and cementless OUKR by other authors as well as retrospective studies, e.g., by Akan et al. [5, 14, 16, 22, 23].

Kendrick et al. conducted one of the few prospective randomized studies comparing cemented and cementless OUKR. While their number of analysed cementless OUKR ($n = 22$) was relatively low and the mean age of the patients receiving cementless treatment was more than 5 years older than in our study (67.6 years), the 2-year follow-up examination shows a slightly higher improvement of OKS (17.7) than in our study and no significant difference from the cemented group [23].

Survival rates in our study were 89.7% in the cementless group and 94.1% in the cemented group. They seem rather low compared to literature findings of cemented OUKR, which range between 95 and 99% [1, 3, 24]. This might be ascribed to the fact that we included the 30 first patients consecutively operated with the cementless OUKR in our hospital. Considering the learning curve with the cementless system (Oxford Phase III), higher survival rates can be estimated with higher numbers of surgery performed [25–29].

None of the main reasons for revision of cemented OUKR (tibial or femoral loosening, pain of unknown origin) were encountered in our study [9]. However, neither did we see tibial component loosening nor pain of unknown origin in our cemented matched-pair collective, while Liddle et al. and Pandit et al. stated that the main causes of revision in cemented OUKR can be avoided by cementless fixation [4, 5]. Additionally, complications that are directly associated with cementation were avoided, whereas in the cemented collective one reoperation was performed due to small cement bodies. Main reasons for revision in this study were progress of OA of other knee compartments, tibial plateau fracture, and inlay dislocation (each one case = 3.4%). Complications found in our study correspond to the findings of Liddle et al., who stated the main causes for revision in cementless UKR to be progression of OA (0.6%), bearing dislocation (0.6%), fracture (0.4%) and infection (0.03%).

Cementless fixation so far renders survival rates between 95 and 100% in follow-up periods ranging between 1 and 6 years [4, 5, 13, 14, 16, 30–32]. In a systematic review by Campi et al., the overall survival rate for various cementless prosthetic designs was 90–99% at 5 years and 92–97% at 10 years [22]. It is difficult to compare these results with the present study, as the published studies are either conducted by developing centres [4, 5, 16], have shorter follow-up periods [13, 30, 31] or include other implant designs [22]. The lack of comparable studies puts emphasis on the conduction of randomised controlled trials from independent centres.

A prospective observational study conducted by Hooper et al. at an independent centre in New Zealand presents the radiological outcome of 150 OUKR and renders a 5-year revision rate of 2 out of 125 patients (1.6%). The authors of this study ascribe the low revision rate to the high number of annual arthroplasties performed by their surgeons rather than to a learning curve for cementless fixation, with an average of 82–106 arthroplasties performed by each surgeon per year. The weakness of this study is its high number of patients lost to follow-up (25 knees). While the overall arthroplasties performed per surgeon per year are comparable to our study, no patient was lost to follow-up, therefore minimizing the bias of this study [32].

Table 2 Patient-related outcome in the matched-pair analysis

Variable	Cementless	95% CI	Cemented	95% CI
Age (years)	62.4	59.5–65.4	61.4	58.0–64.0
Min–max	49–76		49–77	
Sex				
Male	15		15	
Female	12		12	
BMI (kg/m^2)	28.0	26.5–29.4	27.9	26.0–29.6
Min–max	21–38		20–38	
OKS				
Pre surgery (mean; range; SD)	27.1; (15–38); 6.4	24.6–29.7	26.9; (3–40); 8.4	29.9–36.8
Post surgery (mean; range; SD)	42.1; (20–48); 7.6	29.1–45.1	42.0; (27–48); 5.7	15.7–20.4
Change (mean)	15.0	11.8–18.1	15.0	11.6–18.5
AKSS-O	50.7; (21–81); 13.3	45.4–56.0	46.9; (25–74); 13.1	41.6–52.4
	92.7; (59–100); 10.7	88.5–96.9	88.3; (51–100); 12.8	82.7–93.1
	42.0	34.7–49.3	41.0	33.9–48.0
Pain	7.0; (4–10); 1.9	6.2–7.7	7.2; (3–10); 2.1	6.4–8.0
	0.9; (0–6); 1.6	0.2–1.5	1.8; (0–7); 2.2	1.0–2.7
	6.1	5.2–7.1	5.4	4.2–6.5
ROM (°)	120.9; (95–150); 13.4	115.6–126.2	114.4; (85–135); 14.6	109.1–120.9
	128.9; (110–150); 10.3	124.8–133.0	129.5; (100–145); 10.1	125.8–134.0
	8.0	2.0–13.9	15.1	8.5–21.3

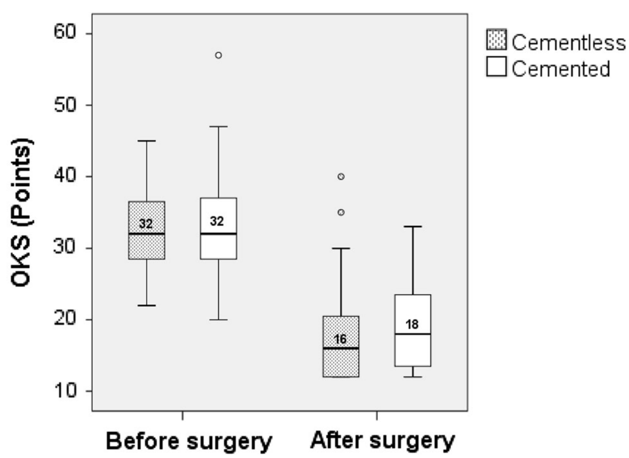

Fig. 4 Improvement of OKS in the cemented and cementless group

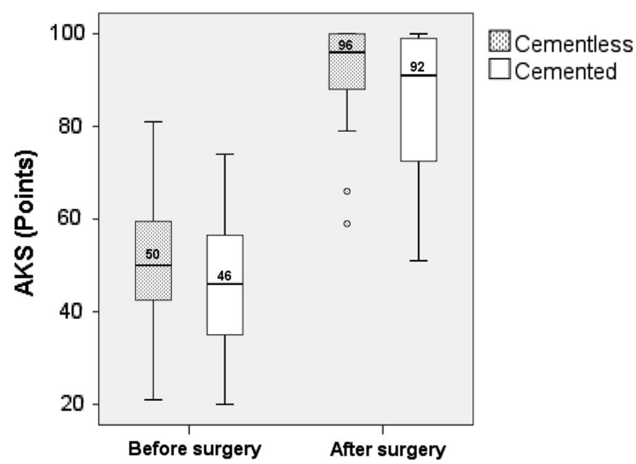

Fig. 5 AKSS-O of the cemented and cementless group

In cementless implantation, tibial plateau fractures are a serious complication. Cadaveric studies have shown that the cementless OUKR is more susceptible to periprosthetic tibial plateau fractures than cemented prostheses, especially when accompanied by an extended sagittal saw cut and decreased bone mineral density [8, 19]. Due to the cementless fixation, more impaction is needed to insert the components with satisfactory primary fit which might increase the risk of consecutive tibial fracture. The careful preparation of the tibial plateau and the following press-fit are challenging procedures and have to be practised. As this study assessed the outcome of the first thirty patients in our hospital treated with a cementless implant, we expect the incidence of tibial plateau fractures to decrease with growing numbers of implants.

The main weakness of our study is the small number of knees analysed. The surgeons' learning curve could have a big influence on the results. Furthermore, the study was designed with a retrospective design, so that selection bias could have influenced the results. Therefore, a prospective study design is currently being set up to avoid these disadvantages and obtain more valid information.

The main strength of this study is that no patient died or was lost to follow-up. All the patients were operated by the same experienced surgeons and got the same post-rehabilitation support. Furthermore, our department has a detailed arthroplasty registry so that the cemented collective could be matched very specifically. In addition, this study was completed in an independent centre showing that the cementless OUKR can be implanted successfully outside the designing centres. The study is among the first trials for cementless OUKR performed with a 5-year follow-up.

Conclusions

Cementless OUKR is a safe treatment of anteromedial OA, with excellent clinical outcome compared to cemented OUKR. There seems to be no difference in the implant survival. Aseptic loosening did not occur in the cementless group of our study, which shows that cementless fixation seems to be a safe and reliable alternative to cemented OUKR. Tibial plateau fractures are a serious complication. The surgical technique is crucial for the success of implantation. To minimize revisions and complications, surgeons should be encouraged to participate in training programmes for cementless OUKR.

Compliance with ethical standards

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest Tobias Gotterbarm has received payment from Zimmer Biomet and DePuy for a presentation and from Springer for a book section. He also received other financial support from Aesculap AG Germany. For another study, he and Tilman Walker were supported from Zimmer Biomet as a Principal Investigator.

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