Comparsion of Mobile-bearing UKA and Posterior Cruciate Ligament Retaining TKA for Patients with Unicompartmental Knee Osteoarthritis:a Retrospective Cohort Study

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Abstract

Introduction*:* Many studies have compared unicompartmental knee arthroplasty (UKA) with total knee arthroplasty (TKA) for knee osteoarthritis suggesting that both procedures had good clinical outcomes. However, there have been fewer studies comparing the mobile-bearing UKA (MB-UKA) and posterior cruciate ligament retaining TKA (CR-TKA) for patients with unicompartmental knee osteoarthritis. Thus, we explored the differences in outcomes and complications between the two cohorts.

Methods: In this retrospective study, 41 patients who underwent MB-UKA and 40 who underwent CR-TKA in our institution were included. All patients were suffered from unicompartmental knee osteoarthritis. Patient demographics, preoperative and latest postoperative range of movement (ROM), Knee Society (KS) scores, and Forgotten Joint Score (FJS) were compared between the two cohorts. Additionally, complications, revisions, and 5-years survivorship were also analyzed.

Results: The results showed MB-UKA patients had similar preoperative ROM and Knee Society pain (KSP), functional (KSF), and clinical (KSC) scores with CR-TKA patients ($p = 0.104$, $p = 0.755$, $p = 0.32$, $p = 0.928$, respectively). The mean follow-up for MB-UKA and CR-TKA groups was 3.4 and 3.7 years, respectively. Two MB-UKA and one CR-TKA patient required revision surgery. The latest postoperative KSF scores, ROM, FJS, and change in KSC scores and ROM were higher ($p < 0.05$) after MB-UKA, but the latest postoperative KSP, KSC, and change in KSF scores were equivalent between the two cohorts. There were no differences in complication, revision rates, and 5-year survivorship estimates.

Conclusions*:* MB-UKA patients showed better functional outcomes and FJS, and higher ROM with similar survivorship compared with CR-TKA patients. MB-UKA should be considered as a primary treatment option for patients with unicompartmental knee osteoarthritis.

Trial registration: researchregistry5032. Registered 23 July 2019, retrospectively registered

Introduction

Surgical options can be chosen to treat knee osteoarthritis (OA). Surgery aims to alleviate pain and improve knee function. Total knee arthroplasty (TKA) has long been considered the gold standard operative intervention for knee osteoarthritis[1, 2]. However, there is an ongoing discussion about the advantages and disadvantages of performing unicompartmental knee arthroplasty (UKA) versus total knee arthroplasty (TKA) for the treatment of patients with unicompartmental knee osteoarthritis[3, 4]. Recently, with the improvement in implant design, surgical techniques and indications, the use of UKA has dramatically increased for patients with medial knee osteoarthritis[5–7]. UKA offers the hope of restoring knee kinematics, decreasing bearing wear and aseptic loosening through increased implant conformity, and lowering polyethylene stresses[8–10]. Advocates of UKA over TKA are arguing that the preservation of both cruciate ligaments, and the remaining intact compartments of the knee, should result in more normal knee kinematics, and quicker rehabilitation. Thus, faster functional recovery of patients may be expected after UKA than TKA[11, 12]. In contrast, the registry data report revision rates were 2 to 3 times higher for UKA when compared with TKA, and advocates of TKA cite it is lower revision rates compared with UKA[13].

To our knowledge, there is limited literature directly comparing the clinical outcomes between MB-UKA and CR-TKA. Therefore, the purpose of this study was to evaluate the survivorship and clinical outcomes of MB-UKA and CR-TKA in patients with medial knee osteoarthritis. We sought to primarily evaluate the range of movement (ROM), Knee Society pain (KSP), functional (KSF), and clinical (KSC) and Forgotten Joint Score (FJS) between the two groups. Second, we sought to evaluate the latest post-operative complications between the two groups. Finally, we evaluated the survivorship due to aseptic loosening as well as revisions of the implant for any reason in MB-UKA and CR-TKA patients. We hypothesized that MB-UKA patients would demonstrate better clinical and functional outcomes than CR-TKA patients.

Materials And Methods

Inclusion and exclusion criteria

A retrospective analysis was conducted to evaluate outcomes following knee joint arthroplasty on data collected between January 2012 and October 2016 on all patients requiring either UKA or TKA, as determined at the time of consultation by the Orthopedic surgeon consulted. All patients received oral and written information about their participation in the registry. They signed a written consent to participate in the registry. The MB-UKA implant used was the Phase 3 Oxford UKA (Zimmer Biomet). The CR-TKA implants used were the Gemini MK-II (LINK®, Hamburg, Germany). The study protocol was approved by the local ethics committee and conducted by following per under the Declaration of Helsinki. Written informed consent was obtained from all patients or their family members before enrollment in the present study. The work has also been reported in line with the Strengthening the Reporting of Cohort Studies in Surgery (Strengthening the Reporting of Cohort Studies in Surgery) STROCSS criteria[14].

Surgical indications for MB-UKA and CR-TKA consisted of the following: isolated medial compartment osteoarthritis, an intact anterior cruciate ligament, flexion contracture < 10°, an active ROM > 90°, varus deformity < 15°, and the patello-femoral joint was only moderately involved. Exclusion criteria included tricompartmental osteoarthritis confirmed by radiograph, failure of lateral stress radiographs and active infection [15, 16]. All surgeries were performed by the same surgeon (Z.S.Y). A comprehensive multimodal anesthesia and analgesia program based on peripheral nerve blocks were used in all groups.

Type Of Measurement Of Postoperative Outcome

The patient demographics for the MB-UKA and CR-TKA groups were shown in Table 1. No patients were lost to follow-up. Preoperative and postoperative ROM, KSC, KSP and KSF scores, and FJS were used to assess patient function at the final follow-up. Preoperative and postoperative ROM was measured with an electric goniometer. The clinical outcomes and complications were then compared between the two groups. Postoperative radiographs in both groups, collected at the latest follow-up, were reviewed by 2 of the authors not involved in the surgical interventions (F.X.L and C.Z) to identify any signs of radiolucency, implant loosening, and bearing dislocation. Survivorship was defined as freedom from revision surgery.

Table 1
Demographics for patients undergoing MB-UKA and CR-TKA

Characteristic	UKA group	TKA group	p-value
Patients(n)	41	40	
Knees(n)	41	40	
Age(years)	63.10 ± 5.50	65.20 ± 6.10	0.107
Gender(male:female)	19/22	17/23	0.333
BMI	22.30 ± 3.20	23.10 ± 3.50	0.286
Pre-operative ROM(º)	112.46 ± 4.40	113.85 ± 3.05	0.104
Pre-operative Knee Society pain score	10.97 ± 6.73	10.50 ± 6.69	0.755
Pre-operative Knee Society clinical score	41.67 ± 8.71	43.53 ± 8.26	0.320
Pre-operative Knee Society function score	50.12 ± 12.57	49.88 ± 12.06	0.928

Statistical analysis

We compared differences in the continuous variables (age, follow-up duration, BMI, ROM, and clinical scores) between the two groups using the non-paired, independent two-tailed Student t-test. We compared differences in the non-parametric continuous variables (revision and complications) between the two groups using Pearson's chi-square test. Significance was set at an alpha value of less than 0.05. SPSS (IBM; version 26.0) was used to perform statistical analysis.

Results

Preoperative results

The mean follow-up time in MB-UKA patients was 3.42 years (range, two to seven years) and CR-TKA patients were 3.7 years (range, two to seven years). The mean age at surgery was similar between the two groups with MB-UKA patients 63.1 years old (range, 51–87 years) and CR-TKA patients 65.2 years old (range, 50–82 years) (p = 0.107). Mean BMI was not significantly different in both groups with MB-UKA patients having a BMI of 22.3 kg/m^2 (range, 19–27 kg/m^2) and CR-TKA patients 23.1 kg/m^2 (range, 19–29 kg/m^2) (p = 0.286). Preoperatively, patients in MB-UKA and CR-TKA groups had similar ROM (112.46° versus 113.85°, p = 0.104), KSP scores (10.97 versus 10.05, p = 0.755), KSC scores (42.39 versus 43.28, p = 0.67) and KSF scores (50.12 versus 49.88, p = 0.928)(Table 1).

Postoperative Results

At final follow-up, patients in MB-UKA group had higher ROM (125.44° versus 119.15°, p = 0.009, Fig. 1) and KSF scores (93.17 versus 84.86, p = 0.04, Fig. 2) than patients in CR-TKA group. There were no significant

differences in KSP between MB-UKA and CR-TKA groups when compared KSP (44.76 versus 45.5, p = 0.721, Fig. 3) and KSC scores (91.22 versus 86.5, p = 0.073, Fig. 4). When considering ROM, KSP KSC and KSF scores improvement from pre-operative levels to a most recent evaluation, MB-UKA patients had greater improvement in ROM (13.02° versus 5.25°, p = 0.004), KSC scores (49.39 versus 42.72, p = 0.04) compared with CR-TKA patients, whereas KSF scores demonstrated a trend toward greater improvement in MB-UKA patients compared with CR-TKA patients that did not reach statistical significance (46.66 versus 36.5, p = 0.11). Further, MB-UKA patients had higher FJS than CR-TKA patients (78.02 versus 63.5, p < 0.001, Fig. 5) (Table 2).

Table 2
Comparsion of postoperative results and difference in mean change between MB-UKA and CR-TKA patients.

Characteristic	UKA group	TKA group	p-value
Follow-up(years)	3.42 ± 1.39	3.70 ± 1.23	0.339
Post-operative range of movement(º)	125.44 ± 11.60	119.15 ± 9.74	0.009
Range of motion improvement(º)	13.02 ± 12.52	5.25 ± 10.88	0.004
Post-operative Knee Society pain score	44.76 ± 10.60	45.50 ± 17.83	0.721
Knee Society pain score improvement	33.78 ± 11.22	35.00 ± 10.25	0.611
Post-operative Knee Society clinical score	91.22 ± 12.99	86.50 ± 10.19	0.073
Knee Society clinical score improvement	49.39 ± 15.85	42.72 ± 12.60	0.040
Post-operative Knee Society function score	93.17 ± 21.59	84.86 ± 14.83	0.040
Knee Society function score improvement	46.66 ± 22.44	36.50 ± 17.04	0.110
Forgotten Joint Score	78.02 ± 11.83	68.50 ± 8.74	0.000
5-years Kaplan-Meier survivorship	93.90%	96.80%	0.485

The total number of complications was lower in the MB-UKA patients compared with the CR-TKA group that did not reach statistical significance (p = 0.274). A summary of postoperative complications is presented in Table 3. In the MB-UKA group, 2 patients were revised at last follow-up, 1 for a bearing dislocation (0.6 years after surgery) and 1 for an aseptic loosening (2.6 and 3.3 years after surgery). In the CR-TKA group, 1 patient underwent developed a deep prosthetic infection and was revised at the last follow-up (2 years after surgery). Kaplan-Meier survivorship at 5 years was 93.9% for MB-UKA and 96.8% for CR-TKA (p = 0.485, Fig. 6).

Table 3
Complications and revisions for patients undergoing MB-UKA and CR-TKA

Characteristic	UKA group n = 41	TKA group n = 41	p-value
Deep venous thrombosis	0	4(10.0%)	P = 0.038
Transfusion	0	1(2.5%)	P = 0.038
Wound dehiscence	1(2.4%)	1(2.5%)	P = 0.986
Arthrofibrosis	0	2(2.5%)	P = 0.147
Deep periprosthetic infection	0	1(2.5%)	P = 0.308
Urinary tract infection	0	1(2.5%)	P = 0.308
Pain	2(4.9%)	1(2.5%)	P = 0.571
Implant loosening	1(4.9%)	0	P = 0.320
Radiographic lucencics	1(4.9%)	0	P = 0.320
Bearing dislocation	1(4.9%)	0	P = 0.320
Surgical revision, any component	2(7.3%)	1(5.0%)	P = 0.571
Total	8(19.5%)	12(3.0%)	P = 0.274

Discussion

To our knowledge, few studies have compared the differences in clinical outcome between MB-UKA and CR-TKA, and this study aimed to examine whether the medium-term outcomes after MB-UKA and CR-TKA were different in a retrospective single surgeon cohort study of patients with medial compartment osteoarthritis. As previous studies often concerned absolute post-operative clinical function scores and ROM, ignoring the change between pre-and post-operative outcomes. The result of our study demonstrated that not only postoperative KSF and ROM, but also the change in KSC and ROM were higher in MB-UKA patients than CR-TKA patients.

Good clinical outcomes and long-term survival for patients treated with UKA have been reported by many centers. Jones et al reported UKA patients can restore near-normal gait at a higher speed compared to TKA patients[17]. Hopper et al reported UKA patients had a significantly greater return to sport rate than TKA patients. UKA patients also took part in more sporting sessions and for a longer period of time than TKA patients[18]. Pandit et al prospectively reported on 1000 MB-UKAs with a 2.9% revision rate, 94% ten-year survival rate with an endpoint of all re-operations. When the failure of the implant was the endpoint, the 15-year survival was 99% [19]. Lisowski et al reported the 15 years survivorship of MB-UKA with revision for any reason as the endpoint was 90.6%[20].

In contrast, some authors and national joint registry have demonstrated TKA has lower revision rate than UKA. Dyrhovden et al reported a 6% TKA revision rate versus 19% UKA revision rate at mean follow-ups of 4.2 and 4.6 years respectively [21]. The Australian Orthopaedic Association National Joint Replacement registry 2019 report concluded that there has been a continuous decline in primary knee replacement revision rates since the Registry commenced data collection. The reasons for this decrease are a reduction in the use of unicompartmental knee replacement and reduced revision for loosening and pain when total knee replacement is used[22]. Similar data were identified in the New Zealand Joint Registry and the UK National Joint Registry[23, 24]. Although these studies demonstrated inferior results to UKAs, the other studies showed that UKA survivorship is strictly determined by surgeon's experience[25].

There has been a controversy regarding whether to retain or sacrifice the posterior cruciate ligament (PCL) during TKA surgery. Many studies have reported the clinical results(ie, knee range of motion (ROM), pain and function) appear equivocal between CR-TKA and PS-TKA[26, 27]. However, there are also many studies with contrary results. The cruciate-retaining (CR) prosthesis has been considered more advantageous in improving proprioception, reproducing physiologic knee biomechanics, and restoring femoral rollback because of the preservation of the native PCL[28, 29]. It also has been suggested that the CR-TKA could improve joint sensation and clinical outcomes[30]. Fewer studies comparing MB-UKA and CR-TKA could be found. A gait analysis between MB-UKA and CR-TKA indicated that MB-UKA has a more physiological gait compared with CR-TKA, a higher top walking speed and no difference in functional outcomes[31]. In our study, MB-UKA group achieved greater functional outcomes and ROM than CR-TKA group in the treatment of patients with unicompartmental knee osteoarthritis. The FJS is a recently introduced score that measures the joint awareness of patients who have undergone knee arthroplasty. Zuiderbaan et al reported that patients who undergo UKA are more likely to forget their artificial joint in daily life and consequently may be more satisfied[32]. The results of our study also showed better results of FJS in the MB-UKA group compared with CR-TKA.

Some studies have reported that UKA has a lower rate of venous thrombosis in comparison with that of TKA[33, 34]. In our study, the DVT rate in MB-UKA patients was lower than that in CR-TKA patients, and the result was similar to the previous reports. Although many studies have reported the UKA has a higher revision rate than TKA. There were 2 patients in MB-UKA group and 1 patient in CR-TKA group underwent revision. The revision rates between the two groups were not statistically different. Survival analysis was used to evaluate the durability of prostheses, 5-year survivorship estimates for UKA and TKA were 93.9% and 96.8%, respectively. The results showed there was no significant difference in 5-year survivorship between the two groups.

There are several limitations to this study. The first limitation of this study is its retrospective, non-randomized design. A selection bias may exist towards performing UKA versus TKA in healthier, lower age and better functioning patients. Secondly, all surgeries were performed by a single surgeon and at a single surgical center. Many studies confirmed surgeon experience was not only essential for achieving good results in joint arthroplasty but also for affecting the revision rate because each surgeon may classify the causes of revision differently[25, 35, 36]. Thirdly, the mean follow-up time was not long enough, and small sample size in both cohort groups. Further larger, multi-center, well-designed RCTs with longer-term follow-up will be necessary to

determine if there are long-term advantages to one procedure over another in terms of functional outcomes, complications and survivorship.

Conclusion

In conclusion, MB-UKA patients showed better functional outcomes and FJS, and higher ROM than CR-TKA patients. This may suggest that MB-UKA should be considered as a primary treatment option for patients with unicompartmental knee osteoarthritis.

Abbreviations

UKA
unicompartmental knee arthroplasty; TKA:total knee arthroplasty; ROM:range of movement; KS:Knee Society; FJS:Forgotten Joint Score; KSP:Knee Society pain; KSF:Knee Society function; KSC:Knee Society clinical; OA:osteoarthritis

Declarations

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Authors' contributions

DW, YL, MR, GM and FH were all involved in the conception and design of the study, the acquisition of data, the analysis and interpretation of data, and drafting the article and revising it. All authors read and approved the final manuscript

Role of the funding source

The funding sources were not involved in the design, collection, analysis, and interpretation of the data, or in the writing of the manuscript

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Availability of data and materials

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

Ethics approval and consent to participate

Trial registration: researchregistry5032. Registered 23 July 2019, retrospectively Registered. All patients received oral and written information about their participation in the registry. They signed a written consent to participate in the registry.

Consent for publication

Not applicable.

Competing interests

All authors declare that they have no competing interests.

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Figures

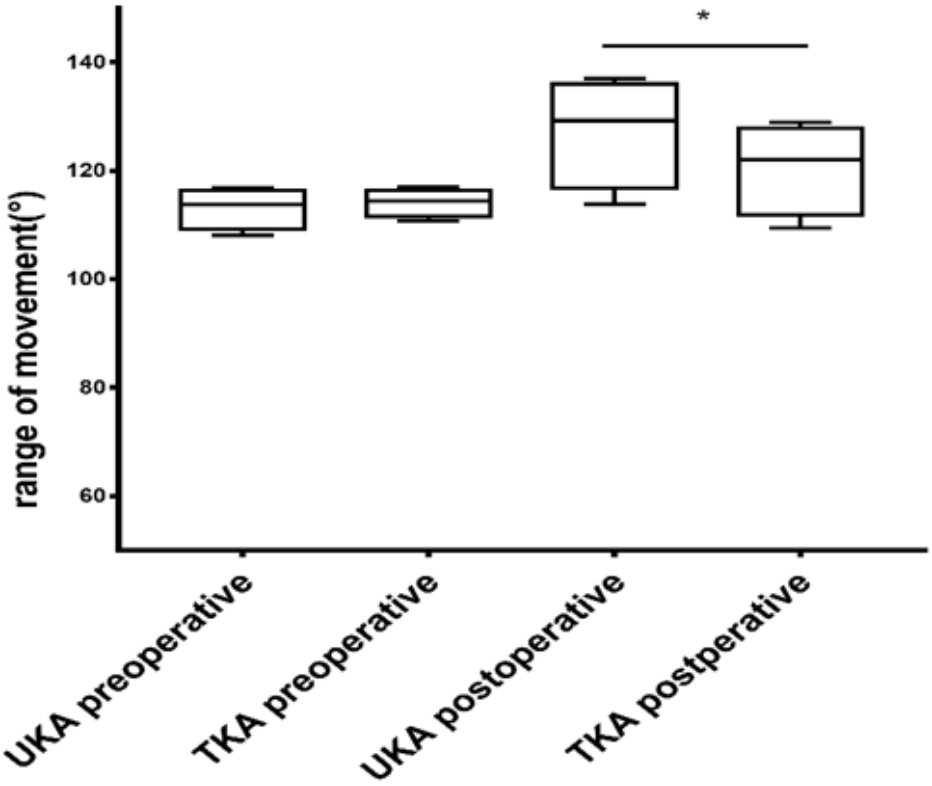

Figure 1

Pre- and postoperative range of movement (degrees) of patients following MB-UKA and CR-TKA , Patients following MB-UKR had a statistically significantly higher postoperative mean ROM, while there was no difference in preoperative ROM. * P<0.05

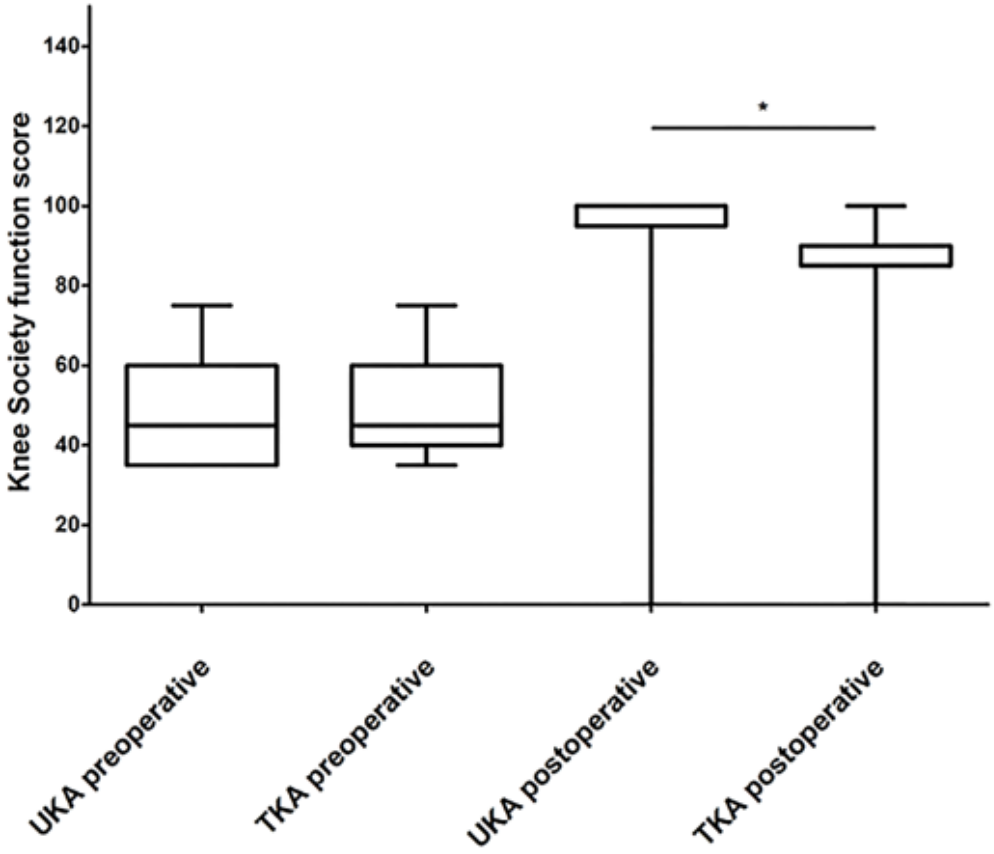

Figure 2

Pre- and postoperative Knee Society function (KSF) score of patients following MB-UKA and CR-TKA , Patients following MB-UKR had a statistically significantly higher postoperative KSF score, while there was no difference in preoperative KSF score. * P<0.05

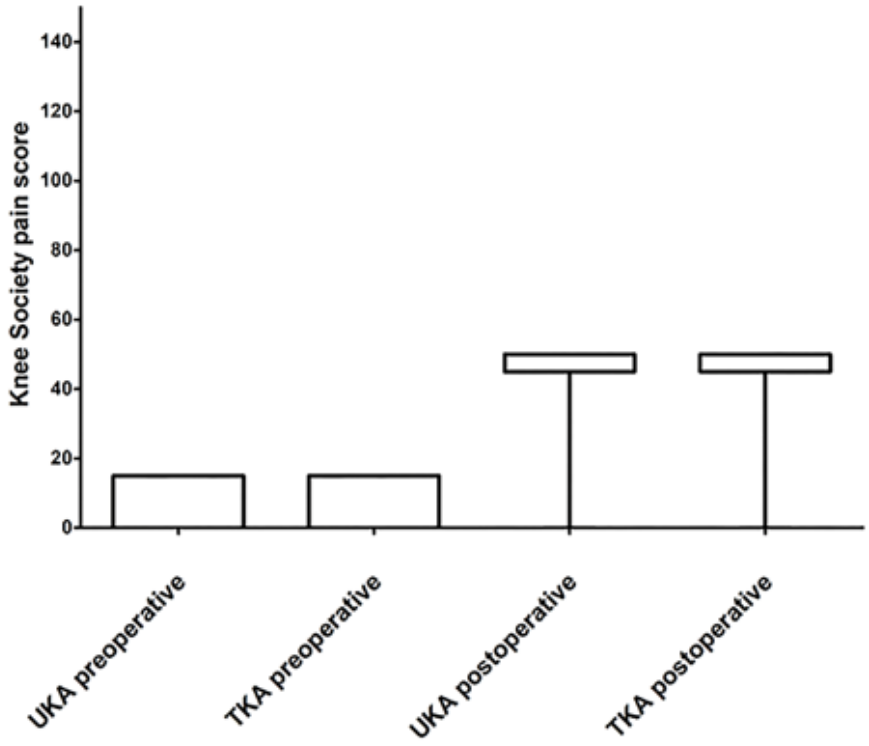

Figure 3

Pre- and postoperative Knee Society pain (KSP) score of patients following MB-UKA and CR-TKA, and there was no difference in pre- and postoperative (KSP) score between the two groups.

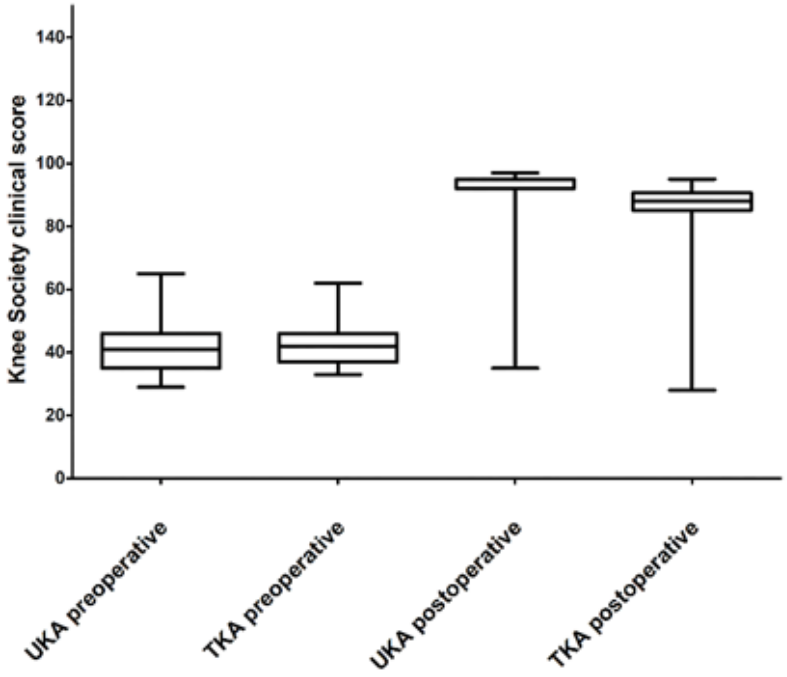

Figure 4

Pre- and postoperative Knee Society clinical (KSC) score of patients following MB-UKA and CR-TKA, and there was no difference in pre- and postoperative (KSC) score between the two groups.

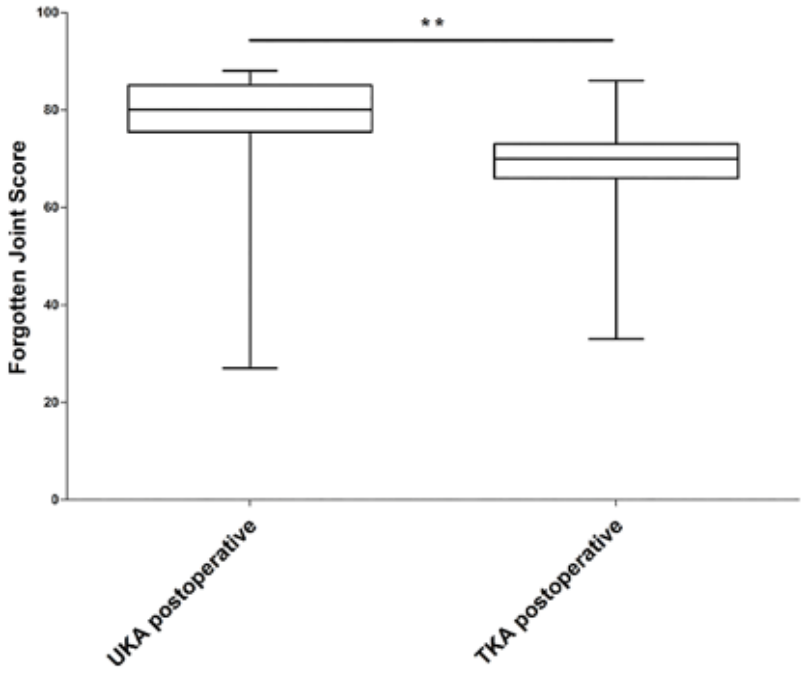

Figure 5

Forgotten Join Score (FJS) of patients following MB-UKA and CR-TKA, Patients following MB-UKR had a statistically significantly higher postoperative KSF score.** P<0.01

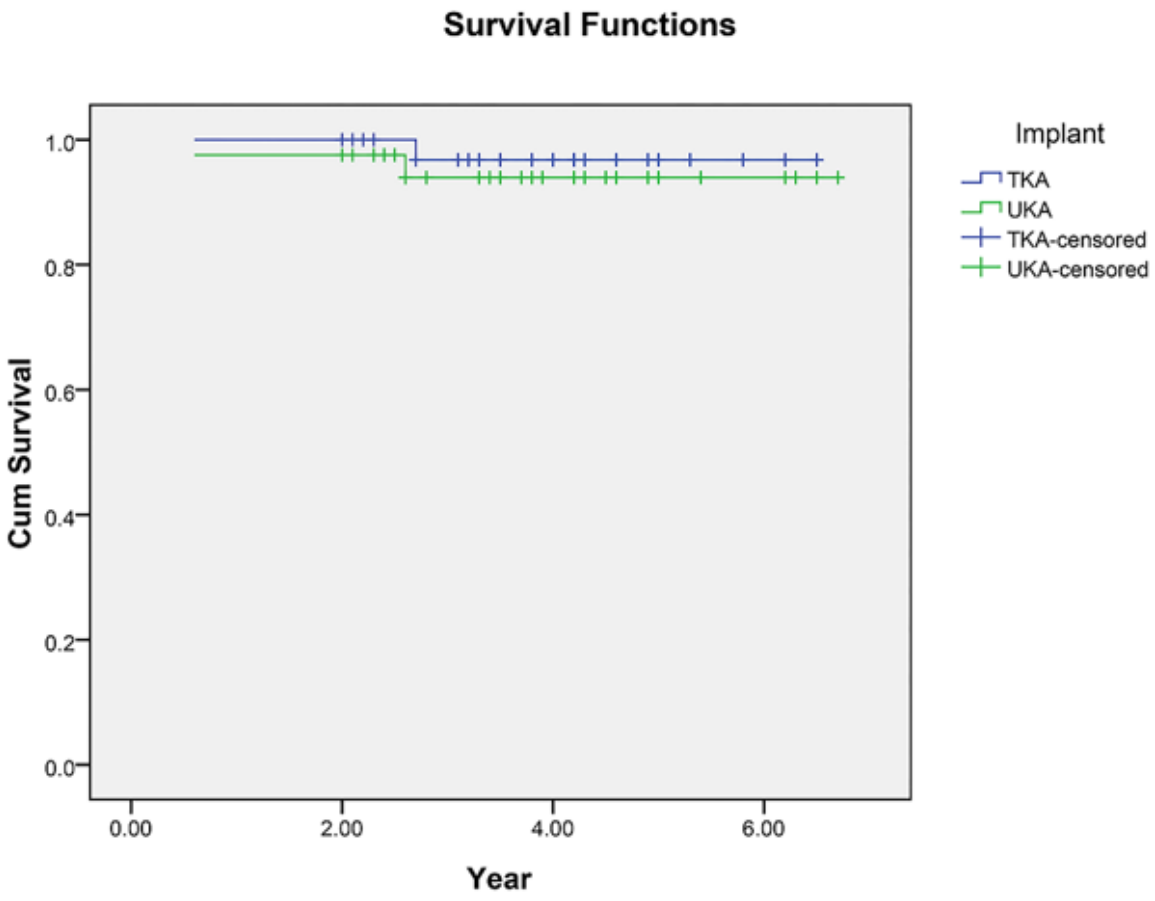

Figure 6

Kaplan-Meier survivorship curve: 5-year survivorship was 93.9% and 96.8% for MB-UKA and CR-TKA, respectively.