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Outcome of revision UKR to TKR when compared to a matched group of TKR of same total arthroplasty lifespan

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Aim: To compare outcomes of revision uni-compartmental knee replacement (UKR) with a defined revision cause with a matched group of primary total knee replacements (TKR).
Background: UKR accounts for 8.7% of knee arthroplasty in the UK each year. It has better functional outcome than total knee replacement for isolated single compartment arthritis but can result in complex surgery when revision is required. This is feared to result in poorer patient reported outcomes when compared to primary TKR. We aim to compare the clinical results of revised UKR with primary TKR, taking into account the survival length of the UKR.
Patients and methods: Forty-five patients (27 female) were retrospectively identified from our arthroplasty database that had undergone revision from UKR to TKR (1999–2014) and had a minimum of two years of follow-up post-revision. These patients were then matched with regards to age at primary procedure, sex, BMI and total arthroplasty life (UKR + Revision TKR) up to point of follow-up.
Results: In the UKR revision group (mean arthroplasty life 8.6 years) the mean Oxford knee score (OKS) was 31.8. In the primary knee group (mean arthroplasty life 8.4 years) the mean OKS was 32.8. This difference was not statistically significant. Fifteen out of 45 patients undergoing revision surgery required stemmed components.
Conclusion: UKR provides comparable clinical outcome even after revision surgery to TKR as primary TKRs and should be considered in all patients meeting the selection criteria. Revision is complex and revision components should be available.

1. Introduction

Medial uni-compartmental knee replacement (UKR) is a popular alternative to total knee replacement (TKR) in patients with single compartment end-stage degenerative joint disease. It accounts for 8.7% of arthroplasty in the UK according to latest registry data [1]. Good medium and long-term results have been reported in single centres [2–4], however joint registry data has shown higher revision rates when compared to TKR [1,5–7]. Revision rates of UKR are 15.96% compared to 5.62% of TKR at 13 years in the UK [1].

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One advantage of medial UKR proposed has been the relative ease of revision to TKR at failure [8,9] with minimal bone loss found [10]. Other advantages include better function, improved range of movement [11,12] and reduced overall costs [13]. However other studies have suggested that revision procedures are far from straightforward with bone loss [13–18] and increased use of revision augmentations and posterior stabilised components [13,19].

Inferior clinical outcomes of revision medial UKRs when compared to matched index total knee replacements have been reported [18–22]. This may be related to the indication for revision [23] and reported poorer pre-operative function [24]. Some studies refute this claiming similar outcomes to primary TKR although others claim the outcomes are more similar to a revision TKR [25,26].

We present the data from our unit. Our hypothesis was that if there was a defined cause for revision then clinical outcomes of patients who had undergone revision of medial UKR to TKR would be equivocal to those of patients who had undergone a primary TKR in the same period as their original medial UKR.

2. Patients and methods

Forty-five non-consecutive patients who had undergone revision medial UKR to TKR in our unit by our senior knee surgeons (1999–2014) and had at least two years (range 24–27 months) of clinical follow-up post-revision were identified from our arthroplasty database. They were selected according the length of their follow-up as numbers were not sufficient in the longer followed up group for the study to remain powered.

Twenty-seven were female and 18 were male. Patient's mean age at primary procedure was 61 years (range 36–82 years). Their mean age at revision was 67 years (range 42–82 years). Mean body mass index (BMI) of the revision group was 33 (range 22–39).

These patients were then matched with regard to sex, BMI, age at initial arthroplasty (within five years) and year of primary procedure (either primary UKR or TKR) giving equivalent total follow-up time. No matching was performed for laterality or type of implant. Mean age of the matched group was 61.2 years (range 42–80 years) which was not significantly different from the revision group ($p = 0.15$). Mean BMI of the matched group was 33 (range 20–41) which was not significantly different ($p = 0.65$).

Medical notes were reviewed. Data were collected on patient demographics, implants, complications, pre- and post-operative range of movement, and patient reported outcome. Oxford knee score (OKS) was the primary outcome measure where 0 was the worst and 48 was the best. Weight bearing Antero-posterior (AP), lateral and skyline radiographs were obtained in all patients before discharge from hospital and were evaluated for component mal-position, sizing inaccuracy, subsidence and radiolucency as per guidelines proposed by Ewald [27]. Tibio-femoral varus–valgus was evaluated to evaluate an indication of survival [28].

2.1. Statistical analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) (Microsoft®, USA) comparing the two groups with the Paired T test for matched parametric data. A power calculation was performed using the formula proposed by Dallal [29].

3. Results

The original cohort of UKRs was all medial and consisted of three prosthesis types; Oxford (Zimmer-Biomet, Warsaw, Indiana) 31%, AMC (Corin, Cirencester, UK) 42%, and St Georg sled (Link, Hamburg, Germany) 27%. Of the patients undergoing UKR to TKR revision, the majority were revised due to progression of arthritis in the other compartments of the knee (76%). The remaining were revised for component loosening (11%), malalignment (four percent), bearing dislocation (two percent), peri-prosthetic fracture (two percent) and infection (two percent).

Components used in revision were based on surgeon's preference; Triathlon (18%) (Stryker, Kalamazoo, Michigan), Gen II (42%) (Smith and Nephew, Memphis, Tennessee), Legion (24%) (Smith and Nephew, Memphis, Tennessee), Kinemax plus (seven percent) (Howmedica, Rutherford, New Jersey), RT plus (two percent) (Smith and Nephew, Memphis, Tennessee), press fit condylar (PFC) (four percent) (Depuy-Synthes, Raynham, Massachusetts), and TC3 (two percent) (Depuy-Synthes, Raynham, Massachusetts). All were revised to total knee replacements with patellar resurfacing. There was variation in the level of articulation constrainment; 47% were cruciate retaining (CR), 31% were posterior stabilised (PS), 20% were constrained condylar (CCK) and two percent were hinge knee replacements. Thirty-one percent required stemmed components (four percent tibial and femoral, 27% tibial) and 40% required either augments or bone graft to fill defects. Eleven percent required augments of which the

Table 1
Pre and post-operative range of movement (ROM) and radiographic alignment.

	Pre-op ROM (°)	Post-op ROM (°)	Pre-op coronal alignment (°)	Post-op coronal alignment (°)
UKR	100 (75–120)	–	8 varus (0–12)	–
Rev UKR	99 (85–125)	105 (85–140)	6 varus (0–15)	5 valgus (3–7)
TKR	94 (50–130)	101 (75–130)	1 varus (10 varus–15 valgus)	7 valgus (6 varus–18 valgus)

majority were used on the medial tibial plateau (mean 10 mm). Thirty-eight percent of patients required bone graft, which was predominantly used in the tibia and was autologous.

Mean pre-operative range of movement (ROM) in the matched group was 94° (range 50–130°) with a mean fixed flexion deformity of seven degrees (range 0–20). Initial ROM (before index UKR) in the revision group was mean 100° (range 75–120°) which was not significantly different ($p = 0.22$). Mean pre-revision UKR ROM was 99° (range 85–125). Mean post-operative ROM in the matched group was 101° (range 75–130°) and was 105° (range 85–140°) in the revision UKR group which was not significantly different ($p = 0.14$) (Table 1).

Mean pre-operative alignment of the patients undergoing UKR revision was six degrees varus (range 0–15°) and in the TKR group one-degree varus (range 15 valgus–10 varus). Mean pre-operative UKR (index procedure) alignment was eight degrees varus (range 0–12°) (Table 1).

Mean preoperative OKS in the matched group of primary TKR was 18.8 (range five to 30). The mean pre-operative OKS in the UKR group pre-revision was 15.1 (range four to 26); this was not significantly different. In the UKR revision group (mean total follow-up 8.6 years, range two to 21) the mean OKS was 31.8. In the primary knee group (mean follow-up 8.4 years, range two to 20) the mean OKS was 32.8. This difference was not statistically significant ($p = 0.73$).

One case experienced an intraoperative fracture of the tibia that was managed with conversion to a stemmed component. No early post-revision complications were recorded in the revision group within the two years that the patients were followed up. Initial radiographic follow-up showed that all knees were within acceptable ranges of alignment, had well sized components and had adequate fixation. Mean post-operative tibio-femoral alignment was six degrees valgus (range three to seven degrees) in the UKR revision group (Table 1). Radiographic follow-up was available in 87% of cases at mean 3.5 years (range one to eight years). There were six cases of tibial osteolysis and loosening, however none were found around the femoral component. None had been revised in this period of radiographic follow-up.

Initial radiographic analysis of the comparison group demonstrated good radiographic alignment in all but two cases where the tibial component was in mild varus in one case and one in mild valgus alignment. One case had mild lateral and one mild medial tibial overhang. Radiographic analysis post-operatively revealed a mean of seven degrees valgus (range six varus–18 valgus) in the matched group which was not significantly different ($p = 0.73$) (Table 1). At radiographic follow-up mean of 8.4 years (range two to 20) there were six cases of tibial osteolysis. No femoral osteolysis was demonstrated. Three of these cases have subsequently been revised for pain and loosening after this clinical follow-up. Complications were 1 haematoma, requiring washout, 2 early stiff knees managed with manipulation under anaesthetic (MUA) and 3 superficial infections, which were managed non-operatively with oral antibiotics.

4. Discussion

UKR implantation accounts for 8.7% of all knee replacements on the UK according to the National Joint Registry Data 2017 [1]. Single centre studies have shown improved outcomes when compared to TKR and comparable survivorship [2–4]. Joint registries however do not support these findings to the same extent with a 13-year failure rate of up to 15.96% of all UKRs compared to 4.16% for cemented TKRs [1]. This may reflect the importance of patient selection and optimal surgical technique afforded in specialist centres undertaking larger numbers of these procedures [8,9]. Indeed surgeons with a caseload >30/year have significantly better eight-year survival than those with a caseload <10. The surgeon's perception of relative ease of revision surgery and lower morbidity compared to a revision of a TKR may lend itself to a lowered threshold for revision surgery. Surgeons and patients may be more willing to consider undertaking such surgery, when compared to an equivalent scenario involving a patient with a TKR in situ. Chou et al. [19] reported a UKR survival rate of 69% at five years, reflecting that this may be the case for non-specialist centres.

Bone loss is reported as one of the common complications of revision surgery. What effect bone loss has on the use of augments and stems varies widely depending on the surgeon's preferred technique, reported uses vary. Some studies reporting augment and stem use in 50–76% of cases [13,19], others report the use of revision components as uncommon. Our series reports the use of revision components at approximately 33% in keeping with other published work.

Cross et al. [30] report revision of UKR to TKR as less technically demanding than TKR revision in terms of tourniquet time and the use of stems/augments. Sierra et al. [31] relate the use of augments to the need to protect damaged bone rather than technical difficulty. Berend et al. [32] relate this to the mode of failure, tibial fracture required higher use of stems and augments as did all polyethylene tibial components. Careful surgical planning must be undertaken before revision UKR surgery is embarked upon to ensure good results [33]. Our series demonstrates the need to have revision TKR components available when performing these cases.

Craik et al. [24] report their series of 29 patients requiring revision at a mean of 25 months. They report better outcomes in primary TKR and primary UKR over revision surgery at a mean of 20 months of follow-up. This short arthroplasty life prior to revision is consistent with other studies [18,19,22]. Thirty-four percent required augments or stemmed implants. Outcomes were related to the pre-revision patient reported scores rather than the complexity of the surgery. Twenty percent of the patients were revised for unexplained pain, which is associated with poor outcome [23]. This study presents groups with similar pre-operative scores and well-defined reasons for revision.

Rancourt et al. [22] report their series of 63 patients revised for failure of Oxford medial UKR. Their mean time to revision was 28 months and mean follow-up was 3.1 years. Twenty-three percent required stems or augments. Revision due to arthritic progression occurred in 61.9%, although 10% were revised for pain with no clear cause. Their patient reported outcomes were significantly worse than primary TKR implanted in the same period.

Both Rancourt et al. [22] and Craik et al. [24] compare their revision patient reported outcome measures (PROMs) with primary TKRs. The time at which these were implanted, was however in the same period as the revision procedure. We do not believe that these are comparable and additional time should be applied to the matched group to allow for the life span of the UKR. PROMs in TKR are reported as highest one-year post-op, they are certainly reduced at five years [34] (which would be a comparable follow-up period for the above studies) and may be reduced at even two years post-op [35]. This should be taken into account for a fair comparison. Leta et al. [26] report registry data that the outcomes of revision UKR are more similar to that of a revision TKR in terms of PROMS, re-revision and complications at a 10 year follow-up. The difficulty of UKR revision has been perhaps underestimated in this group.

This study has several limitations. All data were collected prospectively as part of our arthroplasty database. The case controlled methodology means that the patients were identified retrospectively without randomisation. Several surgeon's data were included in our cohort, as were several different implants. Confounding may exist, surgeon levels of experience and surgical technique might be associated with TKR or UKR. Although data was collected on functional outcome, none were collected on patient satisfaction.

The study methodology does not account for differences that may arise due to the difference in indications that surgeons have for UKR or TKR. We did not match the patients by arthritis type. As the institutional picture archiving and communication system (PACS) system only has a 10-year life span only nine percent pre-operative radiographs were available for assessment in the TKR group. Although the study does exclude inflammatory arthritis, other factors such cruciate ligament incompetence were not accounted for.

Despite its several weaknesses this novel study evaluates an important research question that is not addressed elsewhere in the literature. It is the first study to account for the natural history of a knee arthroplasty when comparing a revision of a UKR and a primary TKR.

This study demonstrates a flaw in the argument that a revision from a UKR to a TKR is inferior to a primary TKR. That argument is a gross simplification of the data, not accounting for temporal factors. Equivocal PROMs were found at time points from index surgery between the TKR patients and the revision UKR to TKR patients. Additionally the patients in the UKR group enjoy higher PROMS in the initial years.

The major argument for primary TKR where UKR is an option remains cost. Although the index procedure may be cheaper in the UKR group the higher revision rate and increased use of costly revision implants for the second surgery overwhelm this.

Although PROM is greater in the UKR group and then equivalent in the revision UKR to TKR group this does not measure the patient experience of undergoing further surgery or the additional morbidity from the additional hospital admission.

5. Conclusion

When UKRs are revised with a well-defined aseptic cause the patient reported outcome may be equivocal to those of patients undergoing primary TKR in the same period as the original UKR. This is the only study to consider temporal factors; the natural history of a TKR is that the PROMs will deteriorate. Future studies making these comparisons should take this into account.

This study is registered within the hospital trust and has received full Institutional Review Body approval.

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