Revision surgery for failed unicompartmental knee replacement : Technical aspects and clinical outcome

Curtis A. Robb, Gulraj S. Matharu, Khalid Baloch, Paul B. Pynsent

From the Royal Orthopaedic Hospital, Birmingham, U.K.

The aims of this study were to determine the complexity of surgery required to revise failed unicompartmental knee replacements and to evaluate the outcome following revision. Between 2000 and 2009, 494 cemented Oxford phase 3 medial unicompartmental knee replacements were implanted, with 24 (4.9%) requiring revision (mean age : 63.5 years ; 58% male). Mean time to revision was 3.0 years. All cases were revised to a cemented total knee replacement, with primary components used in 67% and revision components in 33%. At a mean follow-up of 3.2 years the median Oxford knee score was 33.3% with one knee requiring re-revision (5-year survival 93.3%). Most failed unicompartmental knee replacements could be revised without the need for stemmed implants, augmentation, or bone allograft. When bone loss occured it was commonly on the tibial side. Good functional outcome for the revised unicompartmental knee replacement was achieved and was comparable to primary knee replacement.

Keywords : unicompartmental knee arthroplasty ; revision.

INTRODUCTION

Unicompartmental knee replacement (UKR) provides an alternative to total knee replacement (TKR) in patients with isolated medial compartment osteoarthritis. The phase 3 Oxford UKR is a commonly used UKR prosthesis with a 10-year survival rate of up to 97.1% reported (*14*). Nevertheless, when a UKR fails the complexity of the revision surgery required remains debatable. Some studies, including the designing centre, have reported that the majority of failed UKRs can be converted to a standard TKR (*9,14,21*). In contrast, other authors have observed significant bone defects at the time of revision in up to 76% of cases, which require more complex revision surgery with stemmed implants, augments, thicker polyethylene, and bone grafting (*3,13,19,22,24*).

Similar controversy exists with regards to the clinical outcome following revision of a failed UKR. Whilst some studies have demonstrated functional outcomes comparable to a primary TKR (*9,21*), others report inferior outcomes following revision UKR compared to primary TKR (*3,8,15,19,24*) with a suggestion that the functional outcome may actually

■ Curtis A. Robb, MBChB, FRCS (T+O). Orthopaedic Fellow.
■ Gulraj S. Matharu, BSc (Hons), MBChB, MRCS. Orthopaedic Registrar.
■ Khalid Baloch, MBChB, FRCS (T+O). Consultant Orthopaedic Surgeon.
■ Paul B. Pynsent, PhD, Professor, Director of Research and Teaching Centre.
Royal Orthopaedic Hospital, Birmingham, U.K.
Correspondence : Mr Gulraj S. Matharu, The Royal Orthopaedic Hospital, Birmingham, B31 2AP, United Kingdom.
E-mail : gsm@doctors.org.uk
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be similar to that following revision TKR (*15*). In addition, recent registry data from Australia and New Zealand have demonstrated an increased risk of re-revision following revision surgery for a failed UKR when compared to a primary TKR (*7,15*).

The aims of this study were to determine the complexity of surgery required to revise failed UKRs at an independent centre and to evaluate the outcome following revision surgery. Functional outcome following revision of a failed UKR was compared to that in patients who had undergone primary TKR or primary UKR at the same centre.

PATIENTS AND METHODS

This retrospective cohort study was performed at a single independent tertiary centre. All consecutive patients undergoing cemented Oxford phase 3 medial UKRs (Biomet, Bridgend, UK) between January 2000 and December 2009 were eligible for study inclusion. Details on patient selection criteria for UKR surgery at this institution, as well as the surgical procedure and follow-up arrangements have previously been described in detail (*12*). All patients undergoing subsequent revision surgery for failed UKRs were identified from the institution's prospectively maintained electronic database. Patients were reviewed in the out-patient clinic following revision surgery. This review included clinical examination, pain and functional outcome using the Oxford knee questionnaire (*4*), assessment of activity levels using the University of California at Los Angeles (UCLA) score (*1*), and standard weight-bearing knee radiographs (anteroposterior, lateral, and skyline views). Knee radiographs were evaluated by the system endorsed by the Knee Society (*5*).

Data was collected from the hospital database and patient case notes. Details of patient demographics, index UKR procedure, and revision surgery performed on the ipsilateral knee (date, indication, components used including any stems, augments, polyethylene thickness and bone grafting) were recorded. All complications post-revision, including any additional surgical procedures performed on the ipsilateral knee, were noted. The Oxford knee score (OKS) was expressed as a percentage, with a healthy joint scoring 0% and the worst possible joint 100% (*17*). All patients were contacted by post to determine the final outcome of the revised UKR. Patients were asked to complete the OKS and UCLA score as well as provide details of any further surgical intervention performed on the ipsilateral knee. Non-responders were contacted by telephone to complete data collection. This study was approved and registered with the institutional review board.

Statistical analysis

Defined outcomes of interest were any further surgery (including re-revision) of the revised UKR and the post-revision OKS and UCLA score. All statistical analysis was performed using the R statistical language (*18*). Cumulative survival of the revised UKR was determined using the Kaplan-Meier method, with the Peto method used to calculate the lower 95% confidence interval (CI) (*16*). For the purposes of survival analysis failure was defined as re-revision for any indication. Patients were censored after their last contact with the hospital, whether it was in clinic or by completion of the postal or telephone questionnaire, or after death.

The OKS data was assessed and compared using the median and approximated 95% confidence intervals about the median as previously recommended given that this data distribution is commonly skewed (*17*). The post-revision OKS was compared between patients revised using primary TKR components and those requiring revision TKR components. In addition, the OKS in patients following revision UKR was compared to the published OKS in patients who had undergone primary TKR or primary UKR at the same centre (*12,17*). A statistically significant difference was defined as no overlap between the 95% C.I's about the median.

RESULTS

Patient demographics and details of revision surgery

During the study period 494 UKRs were implanted, with no patient lost to follow-up. There were 24 (4.9%) failed UKRs requiring revision surgery with all revisions performed by five consultant surgeons. Mean age of patients was 63.5 years at the time of revision (range : 52.3 to 77.3 years) and 58% were male (n = 14). Mean time from index UKR to revision surgery was 3.0 years (range : 0.9 to 6.2 years). Indications for revision are given in Table I.

All 24 patients were revised to a cemented TKR : AGC or Maxim 71% (Biomet, USA), PFC Sigma (DePuy, USA) 12.5%, NexGen (Zimmer, USA) 8%, Kinemax (Stryker, USA) 4%, Medial-Pivot

Table I. — Indications for revision surgery in patients with failed unicompartmental knee replacements (n=24)

Revision indication	Knees (%)	Time to failure (yrs)
Aseptic loosening (Femoral)	9 (37.5)	2.1 - 6.2
Aseptic loosening (Tibial)	3 (13)	0.9 - 4.1
Undiagnosed pain	4 (17)	1.2 - 5.7
Patellofemoral pain	4 (17)	1.2 - 3.5
Disease progression in lateral compartment	2 (8)	1.4 -5.1
Deep infection	1 (4)	4.2
Periprosthetic fracture (Tibial)	1 (4)	1.2

(Wright Medical, USA) 4%. Mean polyethylene thickness when revised to a TKR was 12.2 mm (range : 8 mm to 18 mm). Stemmed implants were used in 33% (n = 8) of the revised knees. Five patients had tibial only stems implanted, and three patients had both tibial and femoral stems. In each case the decision to use stemmed implants on the tibia and/or femur was made subjectively by the surgeon intra-operatively after assessing the degree of bone loss and reconstruction required. Three patients had tibial augmentation, with tibial metal augments of 5 mm or 10 mm used in two patients. The other sustained a periprosthetic tibial fracture, which required bone allograft augmentation of the proximal tibia.

Clinical outcome following revision surgery

Mean follow-up after revision surgery was 3.2 years (range : 1.0 to 6.2 years) with all patients still alive. One patient suffered a superficial wound infection which was successfully treated with oral antibiotics. There was one knee requiring re-revision 1.5 years after the revision surgery (initially performed for disease progression in the lateral compartment) giving a five-year cumulative survival of 93.3% (95% C.I 72.2% to 100%) for the revised UKR. The re-revision was performed for persistent knee pain and possible component malalignment, and required both femoral and tibial stems, but no augmentation or bone grafting. The patient continued to have pain despite re-revision.

None of the other 23 revised knees underwent any further surgical intervention. Analysis of the follow-up radiographs from these 23 revised knees demonstrated that 15 knees had no evidence of any radiolucent lines. Of these 15 knees, 12 were primary TKRs and the other 3 were stemmed total knee replacements (2 knees with tibial only stems and 1 knee with both a tibial and femoral stem). The other 8 revised knees did have evidence of radiolucent lines on radiological analysis (Table II). In all cases the radiolucent lines were non progressive, with patients scoring between 1 and 4 (mean 2.3) on the Knee Society radiographic evaluation and scoring system (5).

The median OKS following revision UKR at latest follow-up was 33.3% (95% C.I : 22.7% to 43.9%) and the median UCLA score was 5 (range : 2 to 6). There was no significant difference in the median OKS in patients undergoing revision UKR with primary TKR components (median : 33.3% ; 95% C.I. : 17.2% to 49.4%) compared to those requiring revision TKR components (median 35.5% ; 95% C.I. : 20.3% to 50.6%). The median OKS for patients following revision UKR to TKR (33.3%) was not significantly different to that following primary TKR (29.2% ; n = 1739) and primary UKR (31.2% ; n = 459) at the same centre (12,17).

DISCUSSION

The present study has demonstrated that it was possible to revise most failed UKRs in this series without the need for stemmed implants, augmentation, or bone allograft. In addition, the functional outcome in these patients was comparable to that following primary TKR and primary UKR.

Table II. — Patients with evidence of radiolucent lines (n = 8) graded using the Knee Society roentgenographic evaluation and scoring system (5)

Primary or stemmed revision knee implant	Total Knee Society score*	Details of radiolucent lines
Primary	2.5	1 mm zone 1 tibia (anteroposterior view) 1 mm zone 2 tibia (anteroposterior view) 0.5 mm zone 1 tibia (lateral view)
Primary	2	1 mm zone 1 tibia (anteroposterior view) 1 mm zone 2 tibia (lateral view)
Primary	3.5	1.5 mm zone 1 tibia (anteroposterior view) 2 mm zone 1 tibia (lateral view)
Stemmed (tibia only)	3	1.5 mm zone 1 tibia (anteroposterior view) 1.5 mm zone 7 tibia (anteroposterior view)
Stemmed (tibia only)	1.5	1.5 mm zone 1 tibia (anteroposterior view)
Stemmed (tibia only)	1	1 mm zone 2 tibia (lateral view)
Stemmed (tibia and femur)	1	1 mm zone 6 tibia (anteroposterior view)
Stemmed (tibia and femur)	4	2 mm zone 1 tibia (anteroposterior view) 1.5 mm zone 4 tibia (anteroposterior view) 0.5 mm zone 1 tibia (lateral view)

*All knee scores given for each of the 8 knees are for radiolucent lines of the tibial component only and in all cases these lines were non-progressive on serial radiographs. None of the 8 knees had evidence of any radiolucent lines of the femoral component.

The requirement for revision TKR implants (i.e. stemmed implants and augments) when revising a failed UKR is extremely variable and ranges from 11% to 76% in the literature and 33% in the present series (3,13,14,19,21,22,24). Part of this reported variability may be related to the indication for revision surgery. In the most recent report from the designer centre the commonest indication for revision was lateral compartment disease progression with two of 19 revisions to TKR (11%) requiring revision components (14). It would be reasonable to assume that when further compartments of the knee become affected with osteoarthritis following UKR, replacement of that compartment in the form of a standard TKR is sufficient to treat the disease. However, in the present series and other studies, including an earlier report from the designer centre, aseptic loosening was the predominant cause of UKR failure (3,11,15,22,24). In these studies the requirement for the use of revision TKR implants was as high as 61% (22). Given that aseptic loosening of implants can be associated with progressive osteolysis (20), it is not surprising that bone defects are frequently encountered at revision surgery requiring intraoperative management.

In the present study aseptic loosening was the indication for revision UKR in 50% of cases. These results are comparable with registry reports quoting aseptic loosening as an indication for UKR revision in 36% to 50% (7,15). The results from the present series are also broadly comparable to independent reports on the Oxford UKR, which have observed between 21% and 54% of revisions were performed for aseptic loosening (19,21,24), as well as those studies including a range of different UKR prostheses and reporting revision for aseptic loosening in 44% to 67% of cases (3,22). In contrast lower rates of aseptic UKR loosening requiring revision have been reported by the designer centre (5% ; 1 of 19 revision UKRs performed) (14). These lower rates of aseptic loosening may reflect increased experience with this technically demanding procedure.

A number of strategies can be employed to deal with bone defects at the time of UKR revision, which include the use of stemmed implants, augments, thicker polyethylene, and bone grafting. The present study findings concur with previous reports in that when bone defects occur they are commonly on the tibial side (3,11,22,24). In this series all eight patients with stemmed implants had a tibial stem,

with three of these requiring augmentation achieved using metal blocks or bone allograft. When dealing with tibial bone defects Saragaglia *et al* used metal wedges for defects less than 8 mm or frozen femoral head allograft for those larger than 8 mm, in addition to long tibial stems (*22*). It is recognised that the management of bone defects at revision depends on individual surgeon preference. Some surgeons would prefer to preserve bone stock and therefore use a medial augment with a stem. Others may prefer to remove bone below the defect on the medial side, remove the remaining bone on the lateral side and use a bigger polyethylene insert with or without necessarily using a stem.

Recently concerns have been raised with regards to poor survival following revision of a failed UKR to TKR. In particular the New Zealand joint registry has reported that following 205 cases of revised UKR to TKR there was a four times increased rate of re-revision compared to patients undergoing primary TKR (*15*). Similar findings have been reported by the Australian joint registry, which go on further to state that the outcome of a revised UKR to TKR is comparable to that of a revised primary TKR (*7*). Results from the present study would appear promising with only one knee requiring further surgical intervention so far. However, it is recognised the follow-up period in this series is shorter than registry reports and the cohort is relatively small. Johnson *et al* reported 91% survival at both 5 and 10 years for 77 UKRs revised to TKRs (*9*) which is comparable to that following index UKR at this centre (94.4%) and compares favourably to that following index UKR at some centers (77% to 84.7%) (*3,10,12*).

Pain and functional outcome following revision UKR to TKR in this study was comparable to that following primary TKR and primary UKR at the same centre (*12,17*). Although other studies have also demonstrated these findings (*2,9,21*), these results are contrary to more recent reports published from other institutions and joint registries which suggest functional outcome is inferior to that following primary TKR, with suggestion that it is actually similar to that following revision of a primary TKR at six-months (*3,15,19,24*). Even at longer-term follow-up (mean 10.5 years) of 21 revised UKRs to TKR Järvenpää *et al* reported these patients were

more dissatisfied compared to a matched group undergoing primary TKR, with significantly worse pain, stiffness, and range of motion (*8*).

No difference was found in the present series between the OKS in patients undergoing revision UKR with primary TKR components compared to those requiring revision TKR components. Wynn Jones *et al* similarly found no significant difference in patient-reported outcomes between these two groups (*24*). However an earlier study by Gill *et al* reporting on 30 failed UKRs converted to TKR demonstrated significantly worse functional scores in those patients requiring major osseous reconstruction at the time of revision (*6*). Activity levels in the present study as determined by the UCLA score following revision UKR to TKR were comparable to that reported following primary TKR (*23*), demonstrating most patients were able to participate in moderate activities following surgery, such as swimming, unlimited housework or shopping (*1*).

It is recognised this study has some limitations. The results presented demonstrate the experience of revising UKRs at a single independent tertiary centre and therefore may not be applicable to all institutions. Clinical outcome is also based on a relatively small cohort of patients with short-term follow-up. The small numbers may also limit the conclusions which can be drawn from comparisons made between subgroups. However, this paper represents our institution's complete experience with revising this particular prosthesis and details a consecutive series with a mean follow-up (3.2 years) comparable to a number of similar recently published studies (mean : 2.3 to 3.1 years) (*3,19,24*). In addition, it has been reported there is no significant change in functional outcome following primary TKR or primary UKR after one year (*12,14,17*), hence a minimum follow-up period of one year is considered adequate in the present study for assessing functional outcome.

CONCLUSIONS

This study has demonstrated that most failed UKRs can be revised without the need for stemmed implants, augmentation, or bone allograft. However, when bone loss occurs it is commonly on the

tibial side. Surgeons should therefore meticulously plan any revision UKR surgery and have revision TKR components available, especially if failure is expected to be due to aseptic loosening. Good functional outcome was achieved following revision UKR which was comparable to that following primary TKR and primary UKR at this institution.

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