

Title: Unicompartmental Knee Replacement: Does The Macroscopic Status Of The Anterior Cruciate Ligament Affect Outcome?

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Abstract

Purpose ACL damage is associated with progression of arthritis and whilst in the population undergoing joint replacement in the majority of cases the ACL is intact there is wide spectrum of ACL disease. This study investigates whether the macroscopic status of the ACL affects functional outcome or survival following UKR.

Methods The macroscopic status of the ACL was recorded in 820 cemented Oxford UKRs implanted by two surgeons for the recommended indications. The ACL was considered functionally normal in the setting of anteromedial tibial wear and macroscopically the ACL was normal, had synovial damage or longitudinal splits. The patients were followed up independently with a mean follow-up of 10.3 years (range 5.3-16.6).

Results More marked ACL macroscopic damage was significantly associated with increasing age, male gender and a more extensive anteromedial tibial defect. Patients with more ACL damage had a significantly lower pre-operative AKSS Objective score, however no difference in AKSS-Functional or OKS was detected between groups. At ten years no difference in functional outcome or activity level was found between groups. Compared to those with a macroscopically normal ACL at ten years a significantly greater improvement from baseline OKS score was seen in patients with macroscopically ACL abnormalities. At fifteen years no difference in implant survival, or failure mechanism, was detected between groups.

Conclusion The macroscopic status of the ACL does not affect long term functional outcomes or implant survival and in the setting of an intact ACL macroscopic status is not a contraindication to mobile bearing UKR.

Level of Evidence: Level IV

Keywords: unicompartmental knee replacement, implant survival, functional outcome, anterior cruciate ligament

Introduction

In patients with moderate-severe osteoarthritis who fail non-operative management unicompartmental knee replacement (UKR) is a clinically and cost effective treatment[11,30]. UKR provides significant functional benefits over total knee replacement (TKR), including increased, range of movement, preserved knee kinematics and preserved proprioception[9,22,21]. These benefits have, in part, been attributed to the fact that UKR is minimally invasive retaining the native structures of the joint, including the knee ligaments, in particular the anterior cruciate ligament (ACL).

In the native knee the intact ACL plays a pivotal role in knee kinematics and is important for femoral rollback, the screw-home mechanism and normal gait[14]. In addition the mechanoreceptors within the ACL play a key role in proprioception, loss of which is associated with poor knee function[23]. ACL degeneration is strongly associated with osteoarthritis and a correlation exists between radiological grade of osteoarthritis and degree of degeneration to the ACL[15].

The ACL has been reported to be intact in up to two thirds of patients undergoing TKR (range 25% to 68%) and it is known that the macroscopic status of the ACL is associated with the pathoanatomy of knee arthritis within the joint, with progressive ACL damage associated with an increasing size of anteromedial tibial defect[7,25].

A functional ACL is a requirement for mobile bearing UKR. When mobile bearing UKR is used in ACL deficient knees a significantly higher failure rate, due predominantly to tibial loosening, is observed compared to ACL intact knees or ACL deficient knees treated with simultaneous or sequential ACL reconstruction and UKR[12]. In addition where mobile bearing UKR is performed in ACL deficient knees this is associated with abnormal knee kinematics and bearing movement[19].

Whilst a functionally intact ACL is a requirement for mobile bearing UKR, not all patients have a macroscopically normal ACL. Furthermore it is known that even in macroscopically normal ACL high level of histological abnormalities exist. The outcome of UKR in these patients who have macroscopic abnormalities in the ACL is unknown. As a significant number of patients presenting with anteromedial arthritis have an abnormal, yet intact, ACL and it is important to establish whether it is safe to perform a UKR in these cases. This study investigates the relationship between the macroscopic status of the ACL and the pathoanatomy of arthritis within the knee and the effect of the macroscopic ACL status on the ten year functional outcomes and fifteen year implant survival in a consecutive series of patients treated with medial mobile bearing UKR.

Patients and Methods

The macroscopic status of the ACL was recorded in the first 1000 consecutive cemented Phase 3 Oxford medial UKRs performed via a minimally invasive approach by two designer surgeons (DWM & CAFD). UKR were performed for the recommended indications as described by Goodfellow *et al.* [5]. Details of the cohort have been published previously[17,18]. The ACL was considered functionally normal if it was not friable and fragmented or absent. If there was doubt about its integrity it was assessed at the time of operation with a ligament hook. The ligament hook, held between the surgeons thumb and index finger, was passed posterior to the ACL and drawn in the anterior direction with a firm force applied. The ACL was considered intact where it resisted the anterior force provided by the ligament hook[4].

Patients were assessed and followed up independently. Assessments were performed pre-operatively and at one, five, seven, ten, twelve and fifteen years post operatively by a senior physiotherapist. At the time of surgery a detailed intra-operative record of the status of each of the compartments within the knee was made. The macroscopic status of the ACL was classified as, normal, or having synovial damage or longitudinal splits[4]. Data on the ACL status was available in 820 knees. The size and depth of anteromedial tibial defect as defined previously was measured and classified as: focal ($\leq 2\text{cm}^2$) full thickness cartilage loss (FTCL), extensive ($>2\text{cm}^2$) FTCL, bone loss $\leq 5\text{mm}$ or bone loss $>5\text{mm}$ [24]. Functional outcomes were assessed using the: Oxford Knee Score (OKS), American Knee Society Score Objective (AKSS-O), and Functional (AKSS-F), and the Tegner Activity Score[8,16,27]. As, unlike TKR, the Oxford UKR aims to restore native alignment and not achieve neutral alignment the AKSS-O was also calculated without performing deductions for alignment[6].

All patients were contacted in the previous 18 months to ascertain the current functional status of their knee and incidence of re-operations. Where patients had died information about the status of their knee, and the presence of further operations was obtained via primary and secondary care records as well as via patient's relatives where appropriate. Data was extracted from our prospective database on 1st September 2014.

Statistical methods

A power calculation was performed using the minimally clinically important difference reported for OKS [3]. Using the Altman nomogram for a power of 80% at a significance level of 0.05 and using a standard deviation of 8, a sample size of 80 patients are required to detect a clinically important difference between groups [29].

To detect differences in survival between groups a Mantel-Cox test was performed for implant-related re-operations, which included any re-operations in which components were changed, in which the meniscal bearings were replaced for dislocation, and any re-operations in which new components were inserted. Life-table analysis was performed Confidence intervals (CI) were calculated using the method described by Peto *et al.* [20].

All analyses were performed using SPSS (IBM Corporation, Armonk, New York). Statistical significance was set at $p < 0.05$.

Results

Of the 820 cases where the status of the ACL was recorded, 540 were unilateral procedures and 140 bilateral. In 565 cases the ACL was normal, 116 cases it had synovial damage and 139 cases it had longitudinal splits. Baseline demographics are outlined in table 1. Those patients with longitudinal splits were significantly older and had lower pre-operative AKSS-O scores than those patients with normal ACL.

The size of the anteromedial tibia medial defect increased as the degree of macroscopic damage to the ACL increased ($p < 0.01$). In patients with a macroscopically normal ACL a tibial defect involving bone loss of $>5\text{mm}$ was observed in 25% of cases compared to in almost 50% of cases in those patients with longitudinal splits to the ACL. Figure 1.

All patients were followed up for a minimum of five years with the exception of those who were lost to follow up (4), died (31), underwent revision (15) or withdrew from the study due to poor health (5). Of those patients who withdrew from the study at any time point, all due to medical co-morbidities not associated with their knee, we are not aware of any revisions. The mean follow up was 10.4 years (range 5.3 to 16.6) with 460 knees having a minimum 10 year follow up and 54 knees a minimum 15 year follow-up.

The mean OKS by year following UKR for each of the three groups is displayed in Figure 2. At ten years there was no significant difference in OKS scores between groups ($p=0.94$) with an overall mean score of 40 (SD9) and 79% of knees having good or excellent outcomes[10].

The mean AKSS-O and AKSS-F by year following UKR are displayed in Figure 3. At ten years no significant difference in AKSS-O ($p=0.15$), AKSS-F ($p=0.96$) or Tegner activity score ($p=0.97$) were detected between groups. Table 2.

A significantly greater increase in OKS ($p = 0.04$) and AKSS-O ($p = 0.03$) from baseline score to ten year score, indicating greater improvement in function, was observed in knees with macroscopic damage to the ACL, synovial damage or longitudinal splits, compared to those knees with a macroscopically normal ACL at the time of operation. No significant difference in improvement from baseline at 10 years was seen when assessing AKSS-F or Tegner activity Score. Table 3.

Overall there were 39 implant related reoperations. In the cohort with normal ACL there were 29 reoperations (5.5%) at a mean of 6.0 years (range 0.4 to 14.7 years). Progression of arthritis in the retained lateral compartment (2.1%) followed by unexplained pain (0.9%) and bearing dislocation (0.6%) were the most common indications for revision. In the cohort with synovial damage to the ACL there were two reoperations (1.8%), one for lateral compartment disease progression and one with an unknown indication (operation performed overseas), at a mean of 9.4 years (6.7 and 12.0 years). In the cohort with longitudinal splits to the ACL there were 8 reoperations (6.0%) at a mean of 4.5 years (range 0.2 to 10.3 years). Progression of arthritis in the retained lateral compartment (3.0%) followed by bearing dislocation (1.5%) and infection (1.5%) were the most common indications for revision.

There were two cases of ACL rupture with both knees having macroscopically normal ACL at the time of operation. One case was associated with trauma and initially treated with ACL reconstruction at another hospital but subsequently the knee joint became infected and two-stage revision TKR was performed at 2.1 years. In the second case the ACL rupture was associated with extensive synovitis and the patient underwent TKR at 14.8 years. In both cases primary knee replacement prostheses were used.

When implant-related re-operations are considered failures the fifteen-year survival rate is 90% (95% confidence interval, 72 to 100.0) in those patients with an normal ACL, 96% (95% confidence interval, 68 to 100.0) in those patients with synovial damage to the ACL and 90% (95% confidence interval, 50 to 100) in those knees with longitudinal splits Figure 4. Overall no significant difference in survival existed between groups ($p=0.153$).

Discussion

The most important finding of this study is that the macroscopic status of the intact ACL does not affect long term functional outcomes or implant survival. This study demonstrates in around a third of patients undergoing mobile bearing UKR the ACL is intact but not macroscopically normal and that progressive macroscopic ACL damage is associated with increasing age, male gender, and a more extensive anteromedial tibial defect. In this

cohort there was some evidence that macroscopic ACL damage was associated with lower pre-operative functional scores with a significantly lower pre-operative AKSS Objective score recorded in those knees with longitudinal splits compared to those with those knees with a normal ACL. Following UKR at ten years no difference in functional outcome assessed by the OKS and AKSS Objective and Functional Scores, or in activity level assessed by the Tegner activity Score was found between groups with those knees with macroscopic ACL damage at the time of operation having a significantly greater improvements in functional status from pre-operative, assessed by OKS score, compared to those knees with a normal ACL. At fifteen years no difference in implant survival, or failure mechanism, was detected between groups.

In the native knee ACL injury is associated with instability and a decline in activity[2,26]. Furthermore there is emerging evidence that in patients undergoing TKR, where the ACL is routinely excised, those patients with an intact ACL at the time of surgery have significantly worse functional outcomes post operatively compared to those with those with pre-existing ACL deficiency[1]. This evidence, together with studies reporting improved functional outcomes in ACL preserving procedures such as UKR, compared to TKR, would support that, if intact, the ACL should be preserved[13,28].

This study has found that provided the ACL is not friable and fragmented or absent, as assessed at the time of surgery, the macroscopic status of the ACL should not be considered a contra-indication to UKR. Furthermore we present evidence to suggest that those patients with marked macroscopic damage may benefit more than those patients with a macroscopically normal ACL by virtue of their significantly lower pre-operative functional scores and greater improvement from baseline score at ten years.

The strengths of this study are that it represents a large, consecutive series of patients undergoing UKR, with standardised patient selection and surgical management, and comprehensive, independent, long term follow up. One of the limitations of this study is that the results are based on macroscopic ACL status which is a crude measurement of ACL integrity. None the less we feel the results are valid as pre-operative imaging of the ACL has poor sensitivity and specificity at assessing the status of the ACL and histological data would not be practical to obtain. Furthermore macroscopic status is a clinically relevant and practical to obtain ensuring that the results of this study can be applied directly to clinical practice. Other limitations are that the size of the reciprocal femoral defect was not measured, which is in part due the operative technique leaving the femoral samples sub-optimal for analysis, and that the follow up protocol did not include any objective assessment to assess for ACL rupture. Whilst this remains a limitation, if ACL rupture did occur it would either have been symptomatic, leading to complications which would have affected the clinical assessment, or alternatively it would have been asymptomatic in which case it would have been of no consequence.

This study has demonstrated that macroscopic damage to the intact ACL is associated with a larger anteromedial tibial defect and may be associated with worse pre-operative function. However excellent long term functional outcomes and survival can be seen following mobile bearing UKR provided that the ACL is demonstrated to be intact at the time of surgery by direct assessment with a ligament hook regardless of the macroscopic status of the ACL.

Conclusion

The macroscopic status of the intact ACL is not a contra-indication to mobile bearing UKR.

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