The influence of the presence and severity of pre-existing patellofemoral degenerative changes on the outcome of the Oxford medial unicompartmental knee replacement


From the Nuffield Orthopaedic Centre, Oxford, England

The belief that arthritis of the patellofemoral joint is a contraindication to unicompartmenental knee replacement (UKR) is commonplace. This view was expressed by Kozinn and Scott in 1989, reinforced by Stern, Becker and Insall, and has persisted, despite some evidence suggesting that the state of the patellofemoral joint was unrelated to outcome. The bicompartamental study of the Oxford knee by Goodfellow and O’Connor in 1986 found no relationship between the state of the patellofemoral joint, as seen at operation, and the outcome in a series of 125 patients. This finding formed the basis for the recommendation made by the Oxford group that the state of the patellofemoral joint should be ignored when deciding whether or not to implant a UKR. However, basing the surgical option on such limited evidence is questionable and further study into the influence of the patellofemoral joint on outcome is required.

This study aimed to evaluate the influence of the damage present on the cartilage of the patellofemoral joint on outcome after UKR.

Patients and Methods
We studied 824 knees in 793 patients who had undergone medial Oxford UKR (Biomet, Bridgend, United Kingdom) with the standard surgical procedure, at least one year previously. This was a consecutive series of all patients undergoing Oxford UKR at the institution by two senior surgeons (DWM and CAFD) between January 1998 and September 2005. The exclusion criteria for the study were those established for the Oxford medial UKR as previously described and include failed upper tibial osteotomy, insufficiency of the collateral or anterior cruciate ligaments, a fixed varus deformity (not passively correctable) of > 15° and a flexion deformity > 15°. The mean age of the patients was 66 years (32 to 89) at the time of operation. In 762 patients unilateral procedures were performed, and 31 had staged bilateral procedures. All patients had anteromedial osteoarthritis (OA) and the recommended indications for the procedure, which were OA or avascular necrosis (AVN) limited to the medial compartment of the knee.
The standard minimally-invasive surgical procedure was used. The incision was from the medial pole of the patella to the tibial tubercle. The patella was not dislocated. The state of the patellofemoral joint was examined intra-operatively. The exposure was sufficient for full inspection of the trochlear groove and the medial patellar facet, but a poor view of the lateral patellar facet was obtained.

Cartilage damage and loss was not considered to be a contraindication to UKR. However, two knees excluded from the study that were due to undergo UKR had substantial bone loss with eburnation and grooving in the lateral part of the patellofemoral joint, and were treated with a total knee replacement (TKR).

All patients were assessed independently by physiotherapists using the American Knee Society score (AKSS) and the Oxford knee score (OKS). The latter was scored between 0 and 48, where 48 is the best possible outcome. The relative change in outcome scores was also calculated, as the final outcome is partly dependent on the pre-operative state. Particular note was made of question 12 (Q12) from the OKS, which evaluates the ability to walk downstairs and provides further detail regarding dysfunction of the patellofemoral joint. Patients were reviewed a minimum of one year after surgery. Outcome data were available for all patients, but in a minority of cases the assessment forms were incomplete for some variables. The missing data had a minimal effect on the results because of the overall sample size. To ensure clarity the sample size for each outcome measure is independently stated in the subsequent results tables.

An intra-operative assessment of the status of the patellofemoral joint was recorded for each knee by the primary surgeon (CAFD, DWM) using a method modified from that described by Stern et al. The size of the degenerative area was estimated rather than taking an objective measurement. The patellofemoral joint was divided into three locations: medial patellar, lateral patellar and trochlear. At each location, the surface was graded using a five-point scale: normal (no changes, grade 0), superficial damage (grade 1), partial-thickness cartilage loss (grade 2), focal (< 2 cm²) full-thickness cartilage loss (grade 3) and extensive full-thickness cartilage loss (> 2 cm², grade 4). The same proforma was used and the method of assessment remained the same for the duration of the study period. Locations were subclassified as having full-thickness cartilage loss if they had grade 3 or 4 changes (focal and extensive full-thickness cartilage loss). Grades 0, 1 and 2 were classified as having normal or minor changes. The information from the three locations was then amalgamated to determine whether there was full-thickness cartilage loss (grade 3 or 4) anywhere within the patellofemoral joint.

The independent physiotherapists who performed the outcome assessment did not know the state of the patellofemoral joint at operation.

Two separate analyses were performed: a comparison of outcome between those knees with and without full thickness loss for each location, specifically the medial patellar, lateral patellar and trochlear, as well as at any of these sites; and a comparison of the outcome for knees with different severity of degenerative changes at each location.

The most contemporary post-operative OKS value was used as the primary outcome variable throughout (absolute OKS), although analysis was also performed on other outcome measures, including relative change over time, when appropriate. Incidence data were reported using frequencies. Independent t-tests were performed on the subclassified (full-thickness cartilage loss or not) data, and analysis of variance (ANOVA) with post hoc Tukey tests and Kruskal-Wallis tests for non-normally distributed data were applied for comparisons of severity. A p-value < 0.05 was considered statistically significant.

The power of the study was confirmed prior to analysis. Data on patients with primary medial compartment OA who had undergone cemented Oxford UKR were used to calculate the sample size. A three-point difference on the OKS is considered clinically relevant and existing data suggested a standard deviation (SD) of seven points. Using Altman’s nomogram, the minimum sample size was calc-
calculated to be $2n = 85$ for a power of 90%, with a significance level of 0.05. As the cohorts with full-thickness cartilage loss were much smaller than those without, the actual number of patients needed was considerably larger but provided the smaller cohort had at least 20 patients the study had adequate power.

## Results

The mean follow-up was two years (1 to 7). Overall, 128 knees (16%) had full-thickness cartilage loss somewhere in the joint. Of 785 knees, 100 (13%) had full-thickness cartilage loss at the trochlear, 69 of 782 (9%) had full-thickness cartilage loss on the medial facet of the patella, and 29 of 784 (4%) had full-thickness cartilage loss on the lateral facet.

For each location within the patellofemoral joint the outcome of patients with or without full-thickness cartilage loss were compared. For the primary outcome measure of the absolute OKS, as well as for change in the OKS and Q12 (pain on stairs), full-thickness cartilage loss at any location was not associated with a significantly worse outcome (Tables I and II). Unexpectedly, full-thickness cartilage loss of the trochlea was found to be associated with a significantly better outcome. In these circumstances the final mean OKS for knees with full-thickness cartilage loss was 41.5 ($\pm 8.7$) compared with 39.4 ($\pm 8.7$) for knees without (Student’s $t$-test, $p = 0.02$). In addition, significant differences were also found for change in the OKS (Student’s $t$-test, $p = 0.003$) and change in Q12 (Student’s $t$-test, $p = 0.03$). Overall, the primary outcome of the OKS of knees with full-thickness cartilage loss anywhere within the knee ($n = 128$) was significantly superior (Student’s $t$-test, $p = 0.04$) to that for knees with normal or near-normal surfaces (Table I).

For each location in the patellofemoral joint, full-thickness cartilage loss had no significant influence on the AKSS (objective). For both medial and lateral facets of the patella, it was found that patients with full-thickness cartilage loss had a significantly worse AKSS function than those without. However, this observation can probably be discounted as it was not associated with a significant difference in the more valid variable of ‘change’ in AKSS function.

A one-way ANOVA (with post hoc Tukey test) examining the difference in outcome between knees with different grades of degeneration at each of the locations (medial, lateral, and trochlear), showed that there were no significant differences in outcome between knees with different grades of degeneration at any location.
lateral facet of the patella and the trochlea) revealed a similar pattern; the outcome did not worsen with increasing damage to the patellofemoral joint. On the contrary, knees with trochlear involvement again demonstrated a reverse trend. Knees with the most degeneration (grade 3 and 4 full-thickness cartilage loss) were found to have significantly better self-reported outcome in terms of absolute OKS (Fig. 1) and improvement in OKS (Table III).

Discussion
In UKR, the presence of full-thickness cartilage loss has been considered a contraindication by some authors. The assumption is that the outcome for such patients would be inferior. Our study of patients who have received UKRs has shown that knees with full-thickness cartilage loss in the patellofemoral joint do not have a worse outcome than those with a normal or near-normal joint, and therefore full-thickness cartilage loss should not be considered a contraindication. Paradoxically, the self-reported outcome for patients with full-thickness cartilage loss at some patellofemoral joint locations appears to be better than for those without. This surprising finding requires consideration.

A finding of equivalence between knees with and without full-thickness cartilage loss (rather than the unexpected superiority in favour of knees with full-thickness cartilage loss) is somewhat easier to explain. There are several options. First, similarity in outcome may be related to normal ageing. Postmortem studies have shown that in the patellofemoral joint of elderly people cartilage damage and full-thickness cartilage loss is very common. Hence, much of the damage seen in the patellofemoral joint may not be symptomatic and would not influence the outcome. Secondly, the mechanical benefits of UKR on the patellofemoral joint may influence outcome. The painful articulation between a diseased medial femoral condyle and the eroded surfaces of the patellofemoral joint, in high flexion, would be alleviated by the new contact surface provided by the UKR. Additionally, any overload of the patellofemoral joint from varus deformity would be reduced by correction of the alignment achieved by UKR. Further, osteophytes on the medial condyle may damage the medial part of the patellofemoral joint but these are removed at operation and so would no longer cause irritation.

Although there are a number of possibilities why full-thickness cartilage loss in the patellofemoral joint does not compromise outcome, we cannot offer a satisfactory explanation why, in the trochlear area, full-thickness cartilage loss enhances the outcome. Although this might be as the result of case selection, the strong trend throughout the data suggests this is not the case. A type 1 error is also

![Box plot to show the effect of severity of degeneration on the trochlear surface for 785 knees. The value given across the median line is the sample size for each degeneration category. The error bars represent centiles (2.5% to 97.5% of the data) (PTCL, partial-thickness cartilage loss; FTCL, full-thickness cartilage loss).](image)

### Table IV. Published series of Oxford unicompartmental knee replacement

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number at start</th>
<th>Maximum follow-up (yrs)</th>
<th>Number of revisions</th>
<th>Reasons for revision (number)</th>
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<tr>
<td>Emerson and Higgins</td>
<td>50</td>
<td>6.8</td>
<td>7</td>
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<td></td>
<td></td>
<td></td>
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<td>loosening (1), rheumatoid arthritis (1)</td>
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<td>Keys et al</td>
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<td>Kumar and Fiddian</td>
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<td>tibial plateau fracture (1)</td>
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<tr>
<td>Murray et al</td>
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<td>5</td>
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<td>unexplained pain (1)</td>
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<td>Pandit et al</td>
<td>688</td>
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<td>Price et al</td>
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<td>Vorlat et al</td>
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<td>10</td>
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<td>Bearing dislocation (4), lateral osteoarthritis (5), loosening (5), bearing fractures (2)</td>
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</table>
unlikely, with the appropriate statistical tests having been applied. Most importantly, the fact that patients with such changes are not disadvantaged should provide reassurance to surgeons who are concerned about implanting a UKR when trochlear damage exists. In contrast, albeit not statistically significant, there is a trend towards the results being worse with full-thickness cartilage loss on the lateral side of the patella.

We acknowledge some of the limitations of this study. The sample was skewed as only 16% of the knees had full-thickness cartilage loss at any site in the patellofemoral joint and no patients were included who had greater than grade 4 changes. Patients with severe lateral changes in excess of grade 4 with bone loss and grooving underwent TKR and were not included in this study, even though we recognised that there is no objective clinical evidence to support this allocation. Therefore our material only permits conclusions to be drawn on knees with cartilage damage or full-thickness cartilage loss in the patellofemoral joint, up to and including eburnation. Accordingly, it is still recommended that patients with severe lateral patellofemoral joint arthritis with grooving undergo TKR.

The results are not quite as clear as one would wish. Significant differences in AKSS function were observed in patients who had medial and lateral facet degeneration (Table I) but this difference was not reflected in the change scores (Table II) and therefore can be discounted. It suggests that the scoring systems may vary in their sensitivity and highlights the dangers of depending on a single outcome measure.

Although a number of patients were reviewed at five years or more post-operatively, the majority of the data presented are short term. The long-term outlook of patients with full-thickness cartilage loss in the patellofemoral joint requires consideration. As the indications for Oxford UKR have not changed over the years it might reasonably have been expected that many failures of procedures performed in the presence of full-thickness cartilage loss in the patellofemoral joint would have emerged. We have examined the published literature for series of Oxford UKR performed for patients with anteromedial OA and medial AVN who satisfied the Oxford indications (Table IV). This showed that out of 1701 knees with follow-up of up to 15.6 years there were no revisions attributed to patellofemoral joint problems, but we recognise that case selection may have excluded some patients with full-thickness cartilage loss in the patellofemoral joint. A report based on data from the Swedish Knee Arthroplasty Register, which does not recount the indications for the use of the Oxford UKR, describes the implantation of 699 Oxford UKRs, for which 50 revisions were required. Only one revision was considered to be related to the patellofemoral joint. These data suggest that full-thickness cartilage loss of the patellofemoral joint probably does not lead to failure in the longer term, and therefore that full-thickness cartilage loss in the patellofemoral joint should not be considered a contraindication to UKR.

Our data do not permit us to extrapolate to other UKRs, whether fixed or mobile, but we note that Berger et al19 and Hernigou and Deschamps20 have reported an appreciable number of failures from patellofemoral joint problems in the long term after fixed-bearing UKR.

Assessment of a large cohort of patients undergoing Oxford UKR has shown that full-thickness cartilage loss seen at operation in the patellofemoral joint does not compromise outcome, and does not need to be considered a contraindication to UKR. If patients are found to have severe degeneration in the lateral part of the patellofemoral joint (with bone loss or grooving) they should undergo a TKR.

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References