The implications of damage to the lateral femoral condyle on medial unicompartmental knee replacement


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With medial unicompartmental osteoarthritis (OA) there is occasionally a full-thickness ulcer of the cartilage on the medial side of the lateral femoral condyle. It is not clear whether this should be considered a contraindication to unicompartmental knee replacement (UKR). The aim of this study was to determine why these ulcers occur, and whether they compromise the outcome of UKR.

Case studies of knees with medial OA suggest that cartilage lesions on the medial side of the lateral condyle are caused by impingement on the lateral tibial spine as a result of the varus deformity and tibial subluxation. Following UKR the varus and the subluxation are corrected, so that impingement is prevented and the damaged part of the lateral femoral condyle is not transmitting load. An illustrative case report is presented.

Out of 769 knees with OA of the medial compartment treated with the Oxford UKR, 59 (7.7%) had partial-thickness cartilage loss and 20 (2.6%) had a full-thickness cartilage deficit on the medial side of the lateral condyle. The mean Oxford Knee Score (OKS) at the last follow-up at a mean of four years was 41.9 (13 to 48) in those with partial-thickness cartilage loss and 41.0 (20 to 48) in those with full-thickness loss. In those with normal or superficially damaged cartilage the mean was 39.5 (5 to 48) and 39.7 (8 to 48), respectively. There were no statistically significant differences between the pre-operative OKS or of change in the score in the various groups.

We conclude that in medial compartment OA, damage to the medial side of the lateral femoral condyle is caused by impingement on the tibial spine and should not be considered a contraindication to an Oxford UKR, even if there is extensive full-thickness ulceration of the cartilage.

When considering a patient for medial unicompartmental knee replacement (UKR) there are contradictory recommendations on how much damage to the lateral compartment is acceptable. Some surgeons take the view of Romanowski and Repicci that UKR should be considered as a pre-total knee replacement (TKR) and will accept significant damage to the lateral compartment. Others aim for UKR to be a definitive replacement with a minimal rate of failure, and therefore require the lateral compartment to be in good condition. The manufacturer’s recommended indications for the Oxford mobile UKR (Biomet Ltd, Swindon, United Kingdom) are that the lateral joint space should have full width on a valgus stress radiograph, and if a full-thickness cartilage ulcer on the medial side of the lateral femoral condyle is seen at operation, it can be ignored. However, we are not aware of any study that has investigated whether such an ulcer compromises the outcome of UKR. The aims of this prospective longitudinal study were to identify factors associated with these lateral condyle ulcers and, to determine whether they compromise the outcome of UKR. In addition we present a case report that illustrates the aetiology.

Patients and Methods
Since the phase 3 Oxford UKR was introduced in 1998, every patient at our institution who had a UKR implanted by one of the senior authors (AJP, CAFD, DWM) has been entered prospectively into a database. This study included 769 knees which had a medial phase 3 Oxford UKR with at least one year of follow-up using the Oxford Knee Score (OKS). The database includes the demographics, operative findings, clinical scores, complications and revisions. The operative findings include the state of the anterior cruciate ligament (ACL), the medial and lateral tibiofemoral joints and the patellofemoral joint. The ACL was cate-
The grading system for cartilage damage is a variation of that described by Stern, Becker and Insall and includes the following categories: normal, superficial cartilage damage, partial-thickness cartilage loss, focal full-thickness cartilage loss (< 2 cm²), extensive full-thickness cartilage loss (> 2 cm²), bone loss (< 5 mm depth), and bone loss (> 5 mm). In order to simplify this analysis, the state of the cartilage on the medial side of the lateral condyle was reclassified into four groups: normal, superficial cartilage damage, partial-thickness and full-thickness cartilage loss.

All patients completed an OKS before operation and at least one year after. They had also been contacted during the review to obtain their OKS at the final follow-up.

The prevalence of the various grades of cartilage damage on the medial side of the lateral condyle was determined and the relationships among these four grades and the demographics, operative findings and OKS were analysed. The OKS before operation and at the final follow-up, and the change in OKS between these times were studied.

**Statistical analysis.** Non-parametric statistics (Kruskal-Wallis test) were carried out on the pre- and post-operative OKS values which did not have a normal distribution. The change in OKS was found to be normally distributed and thus parametric statistics, using a one-way analysis of variance (ANOVA) and a t-test, were employed. When the correlations between a lesion of the lateral condyle and patient demographics were analysed, non-parametric tests, the Spearman’s rank correlation (ρ), were used since the classification of a lesion of the lateral condyle is an ordinal variable. The state of the ACL and its relationship with the lesion of the lateral condyle was analysed using Pearson’s chi-squared test.

A power calculation demonstrated that at least 350 patients would be required to detect a clinically significant difference of three points in the change in the OKS between the normal group and those with full-thickness cartilage loss at a power of 80% (α = 0.05).

Patients who required revision for lateral compartment osteoarthritis were identified and the state of their lateral condyle at the primary procedure was noted. We also present a case report which suggests a cause of the full-thickness cartilage loss.

**Case report**

A 75-year-old man presented with severe pain in the medial side of both knees on activity, worse on the right. His OKS for the right knee was 27 (0 to 48). Flexion was from 10° to 100°, and he had a correctable varus deformity of 15°. The anteroposterior weight-bearing radiograph showed complete loss of joint space and substantial bone loss in the medial compartment (Fig. 1a). The lateral radiograph demonstrated a tibial erosion which did not extend to the back of the tibia, indicating that the ACL was functionally intact (Fig. 1b). The valgus stress radiograph taken in 20° of flexion (Fig. 1c) showed that the intra-articular varus deformity was completely corrected, suggesting that the medial collateral ligament (MCL) was functionally intact. The lateral joint space was of full width, demonstrating that the lateral compartment was functionally normal.

The patient was accordingly offered a UKR. At operation, the ACL was found to be intact, albeit with longitudinal splits. The patient satisfied the criteria for an Oxford UKR, which was duly performed (Fig. 2). The OKS was 47 at one year after operation, and 42 at four years.

During the operation a full-thickness cartilage ulcer, measuring about 30 mm × 7 mm, was seen on the medial side of the lateral condyle (Fig. 3). There was a large osteophyte in the notch medial to the ulcer. The ulcer and osteophyte were not considered contraindications to UKR. The pre-operative weight-bearing anteroposterior radiograph
showed that, in addition to the varus deformity and lateral tibial subluxation, the lateral tibial spine impinged on the lateral femoral condyle in the region of the ulcer (Fig. 1a). With valgus stress and correction of the varus deformity and tibial subluxation, the lateral femoral condyle was lifted off the lateral tibial spine. The appearance of the lateral compartment therefore returned to normal, except for osteophytes on the medial side of the lateral condyle (Fig. 1c). These were removed and the varus deformity corrected, so the appearance of the lateral compartment after operation was normal (Fig. 2).

Results
There were 769 medial Oxford UKRs in 690 patients (79 bilateral, 378 men, 391 women and 371 left and 398 right-sided). Their mean age at operation was 66.5 years (32.9 to 87.6). A total of 59 (7.7%) knees had partial-thickness cartilage loss and 20 (2.6%) had full-thickness loss on the medial side of the lateral condyle. The remainder had normal cartilage or superficial damage in this region (Table I). There was no statistically significant difference (p = 0.526) in the pre-operative scores between any of the classifications.

The mean OKS at the final review in the partial-thickness and full-thickness cartilage loss groups was 41.9 (13 to 48) and 41.0 (20 to 48), respectively, whereas for the normal and superficial cartilage damage groups it was 39.5 (5 to 48) and 39.7 (8 to 48), respectively. Although the final scores for the groups with severe cartilage damage were higher than those with normal or superficial damage, the differences were not statistically significant (p = 0.136) (Fig. 4). Similarly, although the mean changes in OKS were higher in patients with partial-thickness or full-thickness cartilage loss than in those with more normal cartilage, this difference was not significant (p = 0.698, Table I).

When relating the state of the ACL to that of the lesion of the lateral condyle (Table II), Pearson’s test showed a highly significant relationship (chi-squared = 128.87, df = 9, p < 0.001). There was also a highly significant (chi-squared = 78.25, df = 1, p < 0.001) association between worsening ACL status and the grade of lateral condylar damage. There was no relationship between cartilage damage and age (correlation coefficient ρ = 0.067), gender (ρ = 0.000) and side (ρ = 0.009).

Five patients (0.6%) underwent revision to a TKR because of osteoarthritis of the lateral compartment at a mean of 5.4 years (1.8 to 8.7). At the time of medial procedure, four had a normal lateral condyle and one a partial-thickness lesion on its medial side.
This study shows that damage to the cartilage on the medial side of the lateral condyle does not compromise the clinical outcome. Indeed, the clinical results were better in the presence of severe cartilage damage than with normal or near-normal cartilage. We therefore conclude that cartilage damage, or even an ulcer on the medial side of the lateral condyle, should not be considered as a contra-indication for the Oxford knee replacement. This conclusion contradicts the recommendations of Kozinn and Scott\(^2\) and others,\(^1^1,1^2\) as they recommend that the cartilage of the lateral condyle should be nearly normal. Having reviewed the literature, we have been unable to find any evidence relating to either fixed- or mobile-bearing UKR showing that the presence of an ulcer on the medial side of the lateral condyle compromises outcome. We therefore believe that it is safe to infer, for the Oxford knee, that damage to the medial side of the lateral condyle can be ignored.

The case report demonstrates the typical appearance of these ulcers (Fig. 3). They are long and narrow, and lie near the medial margin of the lateral condyle. There tends to be cartilage between the ulcer and the medial side of the condyle. The weight-bearing radiographs demonstrate that the ulcers can be caused by impingement of the lateral femoral condyle on the lateral tibial spine.\(^3,1^3\)

### Discussion

This study shows that damage to the cartilage on the medial side of the lateral condyle does not compromise the clinical outcome. Indeed, the clinical results were better in the presence of severe cartilage damage than with normal or near-normal cartilage. We therefore conclude that cartilage damage, or even an ulcer on the medial side of the lateral condyle, should not be considered as a contra-indication for the Oxford knee replacement. This conclusion contradicts the recommendations of Kozinn and Scott\(^2\) and others,\(^1^1,1^2\) as they recommend that the cartilage of the lateral condyle should be nearly normal. Having reviewed the literature, we have been unable to find any evidence relating to either fixed- or mobile-bearing UKR showing that the presence of an ulcer on the medial side of the lateral condyle compromises outcome. We therefore believe that it is safe to infer, for the Oxford knee, that damage to the medial side of the lateral condyle can be ignored.

The case report demonstrates the typical appearance of these ulcers (Fig. 3). They are long and narrow, and lie near the medial margin of the lateral condyle. There tends to be cartilage between the ulcer and the medial side of the condyle. The apparent distance between the ulcer and the edge of the condyle appears larger than it is because of osteophytes in this region. Once these have been removed it becomes apparent that the ulcer is either near or overhanging the edge of the condyle. The weight-bearing radiographs demonstrate that the ulcers can be caused by impingement of the lateral femoral condyle on the lateral tibial spine.\(^3,1^3\)

It seems that for an ulcer to occur there has to be a substantial varus deformity and lateral subluxation of the tibia. If there is a varus deformity without subluxation an ulcer is unlikely to form (Fig. 5). The probable explanation for this is that normally the lateral femoral condyle is approximately spherical and a socket is provided by the lateral tibial plateau, the tibial eminence and the lateral meniscus. Therefore, with varus deformity alone, the femoral condyle rotates within the socket and there is no impingement. Similarly, if there is only a mild varus deformity associated with subluxation, significant impingement does not occur (Fig. 6). However, if there is subluxation and a substantial

### Table I

Results by classification of cartilage damage showing demographics and Oxford Knee Scores (OKS) pre- and post-operatively, with the mean (range) change. The p-values are calculated for change in OKS for the different severities of lesion compared with a normal lateral condyle using an independent-samples t-test

<table>
<thead>
<tr>
<th>Status of the medial aspect of the lateral femoral condyle</th>
<th>Normal</th>
<th>Superficial PTCL(^*)</th>
<th>FTCL(^†)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>470</td>
<td>220</td>
<td>59</td>
</tr>
<tr>
<td>Mean age (range)</td>
<td>65.9</td>
<td>67.9 (42.6 to 87.0)</td>
<td>64.9 (41.6 to 83.7)</td>
</tr>
<tr>
<td>Pre-operative OKS (0 to 48), mean (range)</td>
<td>22.73</td>
<td>22.60 (4 to 45)</td>
<td>24.25 (4 to 41)</td>
</tr>
<tr>
<td>Post-operative OKS (0 to 48), mean (range)</td>
<td>39.47</td>
<td>39.67 (8 to 48)</td>
<td>41.86 (13 to 48)</td>
</tr>
<tr>
<td>Mean years post-operative OKS (range)</td>
<td>3.87</td>
<td>3.34 (1 to 10)</td>
<td>3.62 (1 to 9)</td>
</tr>
<tr>
<td>OKS change, mean (range)</td>
<td>16.7 (-15 to 40)</td>
<td>17.10 (-22 to 41)</td>
<td>17.6 (-5 to 42)</td>
</tr>
<tr>
<td>p-value, compared with normal</td>
<td>-</td>
<td>0.614</td>
<td>0.507</td>
</tr>
</tbody>
</table>

\(^*\) PTCL, partial-thickness cartilage loss

\(^†\) FTCL, full-thickness cartilage loss
varus deformity, the lateral tibial spine will shift laterally relative to the femoral condyle and will impinge (Fig. 1a). If the ACL is functionally intact, the subluxation tends to correct when the varus deformity is corrected (Figs 1a and c), but if the ACL is absent, the subluxation does not correct (Fig. 7). Hence, if a patient has an ulcer caused by varus and subluxation but with an intact ACL, the Oxford UKR will correct these deformities so that the spherical lateral condyle will again articulate with the spherical socket. There will thus be no impingement and the damaged cartilage on the medial side of the femoral condyle will not transmit load, and will not then compromise the outcome. We have found that there is a close correlation between the extent of the arthritis and the severity of the damage to the ACL.14 With increasing damage to the ACL there is increasing varus deformity and subluxation, which explains why the ulcers are more likely to occur in these circumstances.

We believe that the best way to assess the state of the lateral compartment is with a valgus stress radiograph taken in 20° flexion (Fig. 1c) and recommend UKR only if the joint space is of normal width. By this criterion, revision of an Oxford UKR for progression of arthritis is only required in a small minority of cases at 20 years.15 When the lateral compartment is examined at operation, significant damage is often seen even if a full joint space is seen on a stress radiograph. Fibrillation and surface damage are common, and ulcers are...
occasionally seen. These are usually on the medial side of the condyle, but may also be central. Such central ulcers are rare, and although we recommend that, if present, TKR should be performed, we are unaware of any clinical evidence in favour or against this recommendation. Assessment of the lateral compartment by visual inspection alone may be misleading. If a surgeon insists that the lateral compartment should look normal, many cases appropriate for UKR will be rejected. Conversely, if some damage is deemed acceptable, then inappropriate cases may have UKR. This is because if there is visible damage it is impossible to determine the thickness and durability of the remaining cartilage.

In the past, MRI has not been good at assessing the quality of cartilage and so was unreliable in assessing knees for UKR. However, with improvements in the technology it is becoming possible to image cartilage accurately and MRI is likely to have an increasing role in the assessment of the lateral compartment. However, before it supersedes stress radiographs, confirmation will be needed that it is better at both including and excluding appropriate patients.

There are two main weaknesses of this study. First, the data were obtained from patients having the Oxford UKR, so the conclusions relate only to this knee. They could be extended to other devices only if the principles of these procedures were similar to the Oxford, which, in general, they are not. For example, subluxation is considered a contra-indication for fixed-bearing UKR but not for the Oxford, provided the ACL is intact. Similarly, the aim of the Oxford is to correct the intra-articular deformity, whereas for fixed-bearing UKR the aim is usually to correct both the intra- and the extra-articular deformity. The second weakness is that the follow-up is relatively short. Although we are sure that damage to the medial side of the lateral condyle does not compromise the short-term outcome, we cannot be certain that it does not cause failure of the lateral compartment in the long term. However, if the lateral compartment requires revision after an Oxford UKR, this usually occurs between four and eight years. Therefore, if the lateral ulcer was the cause of a high rate of failure it is likely that this study would have detected it.

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References