Dislocation of the bearing of the Oxford lateral unicompartmental arthroplasty

A RADIOLOGICAL ASSESSMENT

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When the Oxford unicompartmental meniscal bearing arthroplasty is used in the lateral compartment of the knee, 10% of the bearings dislocate. A radiological review was carried out to establish if dislocation was related to surgical technique.

The postoperative radiographs of 46 lateral unicompartmental arthroplasties were analysed. Five variables which related to the position and alignment of the components were measured. Dislocations occurred in six knees.

Only one of the five variables, the proximal tibial varus angle, had a statistically significant relationship to dislocation. This variable quantifies the height of the lateral joint line. The mean proximal tibial varus angle for knees the bearings of which had dislocated was 9° and for those which had not it was 5°. In both groups it was greater than would be expected in the normal knee (3°).

Our study suggests that a high proximal tibial varus angle is associated with dislocation. The surgical technique should be modified to account for this, with care being taken to avoid damage to or over-distraction of the lateral soft tissues.

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The medial and lateral compartments of the knee function differently. In the normal knee the articular geometry of the lateral compartment and its soft-tissue constraints allows

considerable anteroposterior movement of the femoral condyle on the tibial plateau¹ which may cause wear with conventional, fixed-bearing, unicompartmental knee replacements.² The design of the Oxford unicompartmental arthroplasty (UCA; Biomet Ltd, Bridgend, UK) aims to achieve normal kinematics with minimal wear by using an unconstrained, fully congruent, mobile bearing which is functionally analogous to the natural meniscus (Fig. 1).³ Full congruity in all positions is achieved by the use of a spherical femoral component.³

When used in the medial compartment, the Oxford UCA has achieved a survival rate at ten years of 95% (95% CI 90.8 to 99.3, number at risk in tenth year 93.5) and a meniscal dislocation rate of less than 1 in 200.⁴ In the lateral compartment, however, 10% of the bearings dislocated.⁵ All occurred in the first year, suggesting that the dislocation was due to characteristics of the patients or to surgical error rather than a problem with the use of a mobile bearing in the lateral compartment. If it is possible to identify the factors which cause dislocation, and to modify the selection criteria or surgical technique accordingly, the outcome after using a mobile-bearing unicompartmental knee replacement in the treatment of isolated osteoarthritis of the lateral compartment would be improved.

In this radiological study we have therefore examined the

Fig. 1

The Oxford (Phase 2) lateral unicompartmental arthroplasty.

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Fig. 2a

Fig. 2b

The anatomical long axis of both the femur and tibia as applied to a) an AP radiograph and of the tibia in b) a lateral radiograph. A bearing dislocation is provided for demonstration purposes only. All study data were collected from predislocation films.

relationship between the positioning or alignment of the component and bearing dislocation.

Patients and Methods

Patient selection. The radiographs of a group of patients previously described by Gunther et al⁵ were reviewed. The 51 patients (47 women and four men) had all received an Oxford UCA for osteoarthritis of the lateral compartment. UCA had been selected on the following criteria: 1) osteoarthritis of the lateral compartment; 2) an intact anterior cruciate ligament; 3) a valgus deformity which was correctable on a varus stress radiograph; and 4) a full thickness of articular cartilage in the medial compartment shown on a varus stress radiograph.

The operations had been carried out between April 1983 and December 1991. The radiographs of 43 patients (40 women and three men) were available for review. We used the postoperative radiographs taken up to six weeks after surgery. These were non-weight-bearing anteroposterior (AP) and lateral views. An image intensifier was used to screen the knee before a final radiograph was taken. The components were aligned parallel to the projected x-ray beam allowing accurate measurement to be made of the plane of the joint.^{6,7}

Experimental method. One author (BJR), who was blind

to patient outcome, performed the radiological reviews. The long axes of the femur and tibia were drawn on the AP view (Fig. 2a) and the axis of the tibia on the lateral view. Full-length radiographs of the limb were not available, and the anatomical long axis of the femur and tibia were therefore represented on the AP film as a line joining the midpoints of the femoral and tibial shafts at two levels, approximately 10 cm apart^{8,9}. In the lateral view the long axis of the tibia was represented by a line drawn along the posterior aspect of the proximal tibial cortex (Fig. 2b).¹⁰ With the axes established, five alignment variables were measured as follows.

Femoral component varus/valgus. This is the angle between a line drawn parallel to the medial edge of the femoral component and the axis of the femur shown as A on Figure 3.

Distal femoral valgus. This is the angle between the perpendicular to the anatomical femoral axis and a line representing the reconstructed distal articular surface of the femur on the AP view shown as B on Figure 3.¹¹ This line was drawn between a point 3 mm distal to the most distal aspect of the medial femoral condyle and the most distal aspect of the femoral component. This angle should normally be approximately 8° to 10°.¹² It is increased if the femoral component is positioned too far distally relative to the medial femoral condyle.

Fig. 3

Alignment variables A to E measured on 46 knees: A, femoral component varus/valgus; B, distal femoral valgus; C, anteroposterior tibial slope; D, tibial component abduction; and E, proximal tibial varus.

Anteroposterior tibial slope. This is the angle between a line drawn along the articular surface of the tibial tray and a perpendicular to the tibial axis on the lateral view shown as C on Figure 3. The Oxford tibial saw guide is designed so that this angle should be approximately 7° , to reflect the anatomical AP tilt of the normal knee.¹³

Tibial component abduction. This is the angle between the tibial axis and a line drawn along the distal border of the tibial tray in the coronal plane shown as D on Figure 3. The saw guide is designed so that this angle should be 90° . An increase is obtained by increasing the abduction of the tibial component relative to the tibial axis in the coronal plane.

Proximal tibial varus. This is the angle between a line

representing the reconstructed tibial joint surface and a perpendicular to the tibial axis in the coronal plane shown as E on Figure 3.¹¹ The articular surface of the tibia is established by joining a point, 3 mm proximal to the medial surface of the tibia, to the most distal aspect of the femoral component (i.e. the upper surface of the meniscal bearing). In the normal knee the plane of the tibial articular surfaces is inclined by 3° varus relative to the perpendicular of the tibial axis.^{12,13} This angle is increased if the upper surface of the bearing is positioned too far proximally relative to the medial tibial plateau. The gender and age of each patient and the thickness of bearing used were recorded.

Error assessment. In order to assess intra- and inter-

observer error¹⁴ the proximal tibial varus angle was assessed twice by two observers on ten radiographs. The value of the SD for the interobserver error was 0.7°, and that for the intraobserver error 0.4°.

Results

The radiographs of the 46 knees were analysed. The knees were grouped according to a history of dislocation. The bearings had dislocated in six knees (six patients; five women and one man) and had not in 40 (37 patients; 35 women and two men). There was no significant difference between the groups with regard to age, gender or thickness of the bearing. The mean age of the patients with non-dislocated knees was 68 years, but for those with dislocated knees it was 70 years. The mean thickness of the bearing at implantation for both groups was 6.5 mm. The thickness of the bearing increases in 1 mm increments from 3.5 mm to 11.5 mm.

The means and SD for each measured alignment variable for both groups are shown in Table I. A multivariate ANOVA showed a significant difference between the two groups ($p = 0.001$) in relation to the proximal tibial varus angle (variable E). If this angle was greater than or equal to 8° the chance of dislocation was 40%. A proximal tibial varus angle of less than 8° gave a 4% chance of dislocation. A multivariate ANOVA showed no significant difference between the groups for the other variables. The power of the study (0.90) was sufficient to detect a difference between the groups of 3° or more.¹⁵

Of the six knees in which the bearing had dislocated, five had radiographs taken at the time of dislocation in order to identify the position of the bearing. In two knees the bearing had dislocated anteromedially into the intercondylar notch, in one laterally and in two anteriorly.

Overcorrection of the tibiofemoral valgus angle (normal 7°) occurred in both groups but to a greater extent in the dislocation group (non-dislocated mean 3.1° (SD 5.1°); dislocated mean 0.2° (SD 3.2°). This difference was not significant.

Discussion

The cause of dislocation of the bearing may be multifactorial. Five variables were assessed although we found that only one was related to dislocation. For this variable,

the proximal tibial varus angle, the relationship was highly significant ($p < 0.001$). For no other variable was there a significant relationship. We found no significant difference between the groups with regard to age, gender or thickness of the bearing. This suggests that even if the cause of dislocation is multifactorial, the proximal tibial varus angle is the most important variable and should be addressed to minimise the risk of dislocation.

In order to interpret the results it is necessary to understand the principles behind the surgical technique. A key step is to equalise the soft-tissue tension in both flexion and extension. The flexion gap is determined by the amount of bone removed from the tibia and the AP slope of the tibial cut, which is determined by the design of the instruments. Soft-tissue balance is then achieved by progressively removing bone from the distal femur until the flexion and extension gaps are equal. The amount of bone which is removed from the distal femur determines the degree of distal femoral valgus. Our analysis demonstrated that neither the AP tibial slope nor the degree of distal femoral valgus were related to dislocation.

In total knee replacement the varus/valgus alignment of the femur with the tibia depends upon the varus/valgus alignment of the components. With a UCA this is not the case since alignment of the limb depends on the proximal or distal positioning of the components relative to the retained medial condyle, and is wholly independent of alignment. Our analysis showed that the alignment of neither the femoral nor tibial components was related to dislocation. This is not surprising since the femoral component has a spherical surface which, like a ball in a socket, remains in congruous articulation with the bearing independent of their relative alignment. If the degree of femoral component varus/valgus is greater than 10°, congruence is lost. In no knee was malalignment greater than 10°.

The single factor which was related to dislocation was the proximal tibial varus. The normal angle is 3° and an increase of 1° is approximately equivalent to raising the lateral joint line by 1 mm. If the proximal tibial varus was 5° or more above normal (i.e. the lateral joint line was raised 5 mm or more) the rate of dislocation was 40%. By contrast, if the proximal tibial varus angle was less than 2° above normal (i.e. the lateral joint surface was raised <2 mm) the rate of dislocation was 4%. Since the distal femoral valgus angle was not related to dislocation, an abnormally high proximal tibial varus angle must be associated with an increase in length of all the soft tissues lateral to the medial compartment. These are the lateral collateral ligament, the iliotibial tract, the popliteus tendon, the lateral capsule and the cruciate mechanism. Lengthening of these could either have occurred at the time of surgery by stretching or cutting or they may have been damaged before operation, or have been congenitally lax. Since the 1990s the popliteus tendon has been routinely divided at surgery since it was thought that it might bowstring across the joint and dislocate the bear-

Table I. Results for the five measured variables (mean $\pm$ SD; degrees) for the six knees (six patients) in the dislocated group and the 40 (37 patients) in the non-dislocated group

Alignment variable	Dislocated	Non-dislocated	p value
Femoral component varus/valgus	5.0 $\pm$ 4.1	4.4 $\pm$ 2.9	0.69
Distal femoral valgus	9.2 $\pm$ 5.7	7.7 $\pm$ 4.4	0.46
AP tibial slope	4.5 $\pm$ 3.8	6.4 $\pm$ 3.8	0.27
Tibial component abduction	91.8 $\pm$ 1.8	90.9 $\pm$ 3.1	0.47
Proximal tibial varus	9.2 $\pm$ 2.6	5.1 $\pm$ 2.7	0.001

ing. Although we have no evidence that this has decreased the rate of dislocation, we recommend that it should be divided. Preoperatively, all patients had varus stress radiographs. If there was significant lateral ligament damage this would have been manifest by overcorrection of the deformity.

If the lateral soft tissues are overstretched the preoperative valgus angle should be overcorrected into varus. Combined values for the distal femoral valgus and proximal tibial varus angles in each limb give its overall alignment. The normal limb has approximately 7° of tibiofemoral valgus. Overcorrection occurred in both groups, but to a greater extent in the dislocated group. Although the difference was not significant, the trend suggests that 'overstuffing' the lateral compartment is associated with a high rate of dislocation of the bearing.

An increased proximal tibial varus angle can be avoided by minimising damage to the lateral soft tissues during surgery and also by avoiding overdistraction of the lateral compartment.

Despite the use of a standardised routine, the accuracy of our measurements of the alignment of the components may have been limited by the use of short-leg rather than long-leg radiographs. Laskin¹⁶ reported intraobserver and interobserver errors as large as 7° using short-leg films. By contrast, Lonner, Laird and Stuchin¹⁷ found insignificant interobserver variability when seven orthopaedic surgeons measured the tibiofemoral angle and tibial alignment on a series of short-leg radiographs. Our experience has been the same since we had intra- and interobserver errors of less than 1°. A prospective study will be needed to confirm this.

We conclude that dislocation of the meniscal bearing in the lateral Oxford UCA is related to the degree of proximal tibial varus, and thus the height of the lateral joint line. The higher the joint line the greater is the risk of dislocation. In order to prevent dislocation care should be taken to avoid damaging or overstretching the lateral soft tissues.

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