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Radiographic evaluation of factors affecting bearing dislocation in the domed lateral Oxford unicompartmental knee replacement

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ABSTRACT

Background: The rate of bearing dislocation with the domed lateral Oxford Unicompartmental Knee Replacement (OUKR) in different series varies from 1% to 6% suggesting that dislocation is influenced by surgical technique. The aim of this study was to identify surgical factors associated with dislocation.
Methods: Aligned post-operative antero-posterior knee radiographs of seven knees that had dislocated and 87 control knees were compared. Component alignment and position and the alignment of the knee were assessed. All bearing dislocations occurred medially over the tibial wall.
Results: Knees that dislocated tended to be overcorrected: Compared with those that did not dislocate, they were in 2° less valgus ($p = 0.019$) and the tibial components were positioned 2 mm more proximal ($p < 0.01$). Although the relative position of the centre of the femoral component and the tibial component was the same ($p = 0.8$), in the dislocating group the gap between the edge of the femoral component and the top of the wall in flexion was 3 mm greater ($p = 0.019$) suggesting that the components were internally rotated.
Conclusions: To minimise the risk of dislocation it is recommended that the knee should not be overstuffed. This is best achieved by selecting the bearing thickness that just tightens the ligaments in full extension, and re-cutting the tibia if necessary. In addition to minimise the gap between the femoral and tibial components through which the bearing dislocates, the femoral component should be implanted in neutral rotation and should not be internally rotated.
Level of evidence: Level IV

1. Introduction

The number of Unicompartmental Knee replacements (UKRs) implanted annually is continuing to increase [1]. The reduced recovery time, improved functional outcome, and decreased mortality and morbidity compared with Total Knee Replacement (TKR) have contributed to this [1–4]. UKRs can either have mobile or fixed bearings. The mobile bearing devices have lower linear wear rates, but they have the potential complication of bearing dislocation. On the medial side the dislocation rate is low, about 0.5%, principally because the medial collateral ligament is tight so the compartment only opens 2 mm [5,6]. However, it is more common on the lateral side as in flexion the lateral collateral ligament is slack so the compartment opens 7 mm on average [5].

The original flat bearing lateral Oxford Unicompartmental Knee Replacement (OUKR) had an unacceptable five-year survival of 82%, primarily due to the high dislocation rate of 10% [7]. To address this, changes to the operative technique were introduced. These included a lateral para-patella approach, internal rotation of the tibial component and measures to avoid elevation of the joint line (such as the avoidance of over-stuffing or over-milling the femur) which had previously been shown to be associated with dislocation [6,8,9]. Although these changes reduced the dislocation rate, it was still unacceptably high, so the components were redesigned. In order to increase bearing entrapment and improve kinematics an anatomic domed tibial component with a biconcave bearing was introduced [8]. These alterations have reduced the overall dislocation rate to 1.7% in the designers' hands and the primary dislocation rate to 0.8% [5,9]. Other surgeons have, however, had a higher dislocation rate. For example, Streit et al. [11] have reported a dislocation rate of 6.2% in a series of 50 patients.

The aim of this study was to review the post-operative Antero-posterior (AP) radiographs of a series of Domed OUKRs to compare the radiographic features in patients with and without a bearing dislocation. It is hoped that this analysis will help identify key surgical causes of bearing dislocation in patients with domed lateral OUKR.

2. Methods

We were able to identify seven knees with domed lateral OUKR (Biomet, Swindon, UK) that had a history of bearing dislocation from our institution. As controls, we identified 94 knees with domed lateral

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OUKR (Biomet, Swindon, United Kingdom) with good quality post-operative radiographs. The control group comprised of all patients with domed lateral OUKR who had screened radiographs with radiographic beam parallel to the tibial component, thereby allowing an accurate assessment. The knees that had the X-ray beam excessively rotated relative to the components were excluded. These radiographs were identified by comparing the width of the vertical wall of the tibial component with the actual width. The radiographs were deemed to be 'perfectly aligned' if this measurement was within ±5% of the actual tibial component vertical wall width.

All patients met the criteria for having a lateral OUKR: 1) isolated bone-on-bone osteoarthritis in the lateral compartment; 2) an intact anterior cruciate ligament; and 3) a valgus deformity that was correctable [13]. Seven of these knees had a history of bearing dislocation. The previously described standard surgical technique for domed lateral UKR was used [6,10]. The tibial resection was done just above Gerdy's tubercle and was recut if a size 3 bearing could not be accommodated. No ligament releases were undertaken. The aim was to restore normal ligament tension. This was done by implanting the femoral component anatomically and selecting the bearing that just tightened the lateral collateral ligament. In flexion the lateral collateral ligament was slack.

The post-operative radiographs were non-weight bearing and were taken with the X-ray beam aligned with the tibial components [12]. One author, (AG), who was blinded to patient outcomes, performed radiological reviews. All analyses were performed in MATLAB version 7.4 (MathWorks, Cambridge, UK). Prior to radiograph evaluation, the sizes of the femoral component and the bearing implanted were retrieved from the patient's primary operation note. The radiographs were analysed in the following manner.

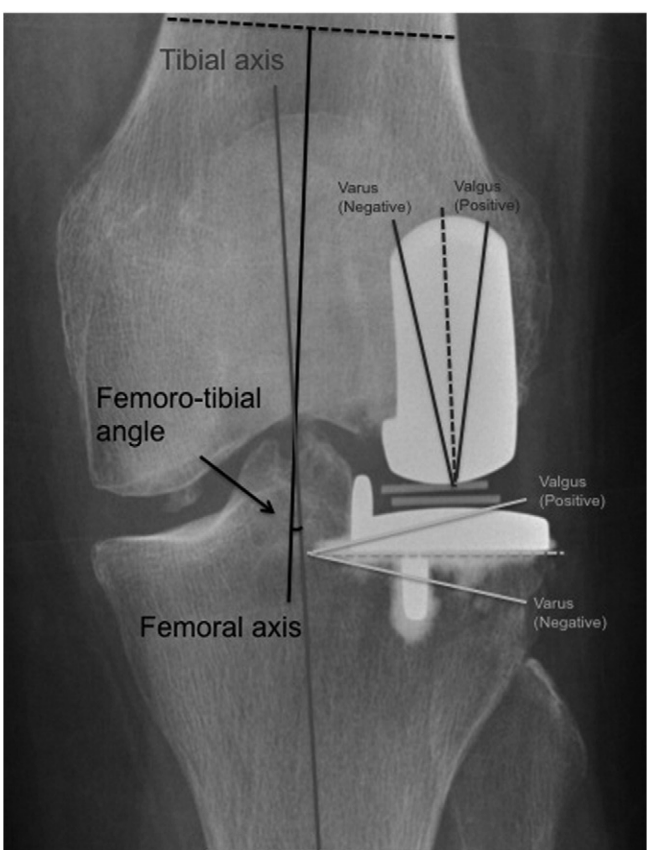

Fig. 1. An AP radiograph of a left knee with a lateral domed OUKR implanted and illustrating how the alignment of components was measured.

Joint evaluation

The long axes of the femur and tibia were drawn on the AP view (Fig. 1). Full-length radiographs of the limb were not available, so the anatomical axes were defined as the lines joining the centre of the femur and tibia, 10 cm from the knee joint surfaces, and the centre of the knee [13,14]. The centre of the knee was defined as single-point at the centre and base of the tibial spines as this has been shown to correlate better with the hip–knee angle [13]. The anatomic angle of the knee was the angle between these two axes. The varus/valgus alignments of the femoral and tibial components were measured relative to the long axis of the tibia (Fig. 1). For all angular measurements neutral was considered to be 0° (with varus values designated as being negative).

Nine additional measurements were taken (Fig. 2). These measurements were chosen as they provided the most consistent points from which to evaluate the component position relative to each other and bony landmarks. A circle matching the inferior border of the femoral component was drawn. In order to calculate the magnification of the radiograph, the radius of this circle was measured and was compared with the known radius of the femoral component. A line (the tibial line) was drawn perpendicular to the tibial component along the lateral part of the vertical wall of the component. A further line was drawn parallel to this from the tip of the lateral tibial spine (the spine line). All measurements were expressed in millimetres (mm).

Measurement 1: The shortest distance between the centre of the circle around the femoral component and the tibial line. This assesses the relationship between the centre of the femoral component and tibial component and thus the distance between the centre of the bearing and the tibial wall.

Measurement 2: The distance between the closest part of the femoral component to the tibial line.

Measurement 3: The distance from the lower corner of the femoral component to the tibial line. This gives an indication of the position of the distal part of the femoral component relative to the tibial component.

Measurement 4: The amount of tibial component lateral underhang. Negative values represent overhang.

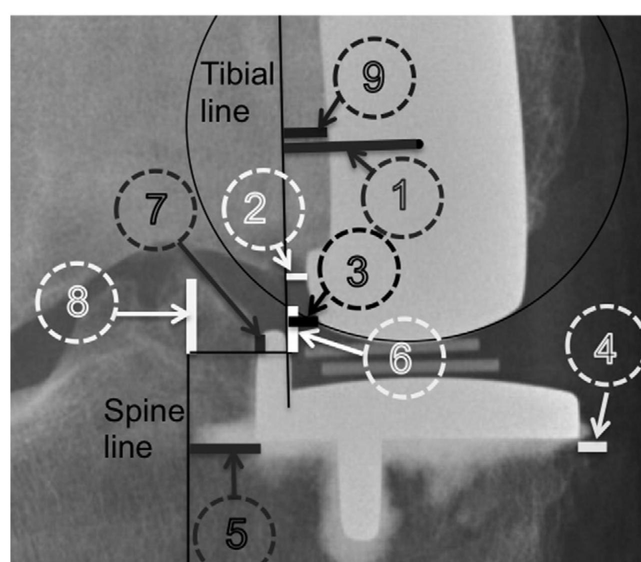

Fig. 2. An AP radiograph of a left knee with a lateral domed OUKA implanted and illustrating the measurements.