Valgus Subsidence Of Cementless Mobile-bearing Unicompartmental Knee Replacement: Clinical Appearances And Investigation Of Mechanism

Alexander D. Liddle, MRCS¹, Elise Pegg¹, Michael J A Mentink, MSc (Eng)¹, Hemant Pandit¹, Harinderjit Singh Gill, PhD², David Murray¹.

¹University of Oxford, Oxford, United Kingdom, ²University of Bath, Bath, United Kingdom.

Disclosures:
A.D. Liddle: None. E. Pegg: None. M.J. Mentink: None. H. Pandit: 2; Biomet. H.S. Gill: 2; Smith and Nephew. 3B; Smith and Nephew, JRI. 5; Stryker, Smith and Nephew, Biomet. D. Murray: 1; Biomet, Synvasive. 3B; Biomet. 4; Bluebelt technologies. 5; Biomet, Stryker, Zimmer.

Introduction: Cementless medial mobile-bearing Unicompartmental Knee Replacement (UKR) was introduced to provide more reliable fixation and to eliminate the problems associated with cementation. Initial studies have demonstrated improved fixation by radiological measures with no increase in complication rate when compared to cemented UKR [1, 2]. However, a small number of cases have been identified which demonstrate early tibial component subsidence into valgus. It has been hypothesised that these appearances result from impingement of the mobile bearing against the lateral wall of the implant in the early post-operative period, prior to full osseointegration. The aims of this study were twofold. The first was to describe the appearances and natural history of these cases. The second aim was to test the bearing-wall impingement hypothesis using an in vitro model of the bone-implant interface in cementless mobile-bearing UKR.

Methods: Users of the cementless UKR were contacted to report any cases that had demonstrated valgus subsidence of the tibial component in the early postoperative period. The clinical data were collected and are described. Serial radiographs were analysed. In patients who had undergone revision, the intraoperative appearances were described and, where possible, the explants examined.

An in vitro model of tibial loading was constructed to test the hypothesis that bearing-wall impingement was responsible for the appearances observed. Cementless UKR tibial components were implanted into commercially-available cellular polyurethane blocks which have been demonstrated to have similar mechanical properties to cadaveric bone (0.32g/cm2, Sawbones inc., Malmo, Sweden). Thin-film pressure sensors (Tekscan inc., South Boston, MA) were interposed between the underside of the tibial tray and the ‘bone’ surface, medial and lateral to the tibial keel. Samples were inserted into a bidirectional vice and loads were applied using a servo-hydraulic material test machine (Dartec series HC10, Dartec ltd, Stourbridge, UK).

Two separate tests were undertaken. Test 1 was intended to recreate normal knee movement. Loads were applied through the mobile bearing. For each load, the position of the bearing was determined by data from a previous study of the kinematics of mobile-bearing UKR [3]. Loads were derived from previous studies of instrumented TKR [4, 5]. Loads were applied to simulate a single ‘step up’ task, with normal bearing tracking. One load was applied to correspond to each 10º increment of the activity. Test 2 recreated bearing-wall impingement. Loads were applied in a position corresponding to 90º of knee flexion. The bearing was positioned in five positions from medial to lateral, and in lateral-most two were induced to impinge on the lateral wall of the tibial tray. For each bearing position in each test, five repetitions were undertaken with different tibial components.

Data from the material Tekscan sensors were collated and interpreted using a Matlab program (Matlab v 7.14, The Mathworks, Nantick, NJ). Following the tests, the tibial trays were explanted and examined using a laser profilometer. Data from each output were entered into Stata v.12 (Stata Corp, College Station, TX) for statistical analysis.

Results: Data on six cases were retrieved and analysed. All describe pain in the early post-operative period during loading of the flexed knee. In all cases, radiographs demonstrated subsidence of the tibial tray into valgus with an increased posterior slope (Fig. 1). Two cases were revised early: one tibia was well-fixed, and a second had partial bone ingrowth. A third case was explored, found to be secure and treated with replacement of the mobile bearing and removal of an impingement lesion. All four cases with the prosthesis in situ demonstrate secondary osseointegration (Fig 2) and clinical improvement over the two years post-operative.

During test 1, the centroid of pressure remains slightly medial to the tibial keel during the arc of knee flexion. In this test, there was no significant difference between the loads medial and lateral to the keel (Fig 3). Laser profilometry demonstrates a minimal impression made by the implant on the underlying polyurethane block.

During bearing-wall impingement, the bearing is observed to tip, leading to a sudden lateralisation of the pressure centroid with high pressures lateral to the keel (Fig 4,5). Analysis of the polyurethane blocks demonstrates that the tibial tray has tipped into a valgus-posterior position as demonstrated by the cases described above.

Discussion: We describe a previously un-described complication of cementless mobile-bearing UKR. The natural history of these cases appears to be benign with secondary osseointegration and clinical improvement. Examination of a simplified model of tibial loading supports the hypothesis of bearing-wall impingement in these cases. We suggest that scrupulous attention to the
orientation of the tibial cut should avoid these appearances. If such cases present, we advise against early revision as the natural history of the cases described suggests a benign course in these cases.

**Significance:** Surgeons should be aware of this unusual complication of cementless mobile-bearing UKR. The loading study supports the hypothesis of increased lateral loading as a result of bearing-wall impingement. Knowledge of the causes and optimal management of such cases may allow better long-term results in patients of this type.

**Acknowledgments:**

**References:**