In Vivo Knee Kinematics of ACL-deficient Patients after Unicompartmental Knee Arthroplasty

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Disclosures:
E.C. Pegg: 3B; Biomet. 5; Biomet. **B. Popat:** None. **M. Alinejad:** 3A; Biomet. **B.H. van Duren:** None. **D.W. Murray:** 1; Biomet; Synvasive. 3B; Biomet. 4; Bluebelt Technologies. 5; Biomet; Stryker; Zimmer. **H.G. Pandit:** 2; Biomet.

Introduction: In cases where a patient has arthritis in the medial side of their knee and has anterior cruciate ligament deficiency (ACLD), an operating surgeon has three options; (1) perform unicompartmental knee arthroplasty (UKA-ACLD), (2) perform unicompartmental knee arthroplasty and also reconstruct the ACL (UKA-ACLR), or (3) perform total knee arthroplasty (TKA-ACLD) which would require sacrificing the ACL even if it were present and functioning. Performing UKA in patients with a deficient ACL is normally avoided because there is evidence that it may increase the risk of tibial loosening [1]; however, in certain cases, upon patient request, the operation has been performed in our centre. A recent study examined these UKA-ACLD patients and found no evidence of loosening, and equivalent patient recorded outcomes to patients with an intact ACL (UKR-ACLI) [2]. The purpose of this study was to examine a subset of this cohort of UKA-ACLD patients in terms of their knee kinematics and compare to historical data controls (UKA-ACLI, UKA-ACLR, and TKA-ALCD).
Methods: Six patients with seven ACL-deficient knees who had undergone mobile unicompartmental knee arthroplasty were examined. The study was approved by the Bristol Research Ethics Committee in January 2013, reference 13/SC/008. All of the primary operations had been performed between February 2004 and February 2012.
For the fluoroscopic analysis, each patient was instructed to perform a step-up exercise, followed by a weight-bearing deep knee bend and fluoroscopy images were recorded as each exercise was performed. A calibration grid was imaged after each exercise to enable any image distortion to be removed. For each video frame (each video had ~50 frames) the patellar tendon angle (PTA) and the knee flexion angle (KFA) was manually measured using a custom software developed using MATLAB (MathWorks Ltd.). The results of the kinematic analysis were compared to previous work by Pandit et al. on UKA-ACLR knees [3], UKA-ACLI knees [3], and TKA-ACLD knees [4]. Non-parametric Mann-Whitney-U tests were used to examine significance between PTA results, and a Standard t-Test was used to examine difference in the cohorts.
Results: The cohort for the UKA-ACLD group were significantly older than the UKA-ACLR and UKA-ACLI cohorts studied by Pandit et al. and had approximately double the mean time to follow up (Table 1), but no statistical difference was found between the ages of the UKA-ACLD and the TKA-ACLD groups. For the UKA-ACLD patients the PTA reduced with increasing KFA in the same manner previously observed in the UKA-ACLI and UKA-ACLR patients; however, the PTA was significantly reduced overall (Figure 1).

Table 1: Patient cohort details compared with those published by Pandit et al. [3][4]

	UKA-ACLD	UKA-ACLR [3]	UKA-ACLI [3]	TKA-ACLD [4]
Mean age (SD) [Years]	68 (14.1)	49.1 (8)	49.2 (7.3)	70.6 (6.1)
Gender distribution	6 Male / 1 Female	10 Male	10 Male	6 Male / 8 Female
Follow up, mean (Range) [Years]	6.4 (1.3-8.7)	3.3 (3-5)	3.4 (3-5.5)	-

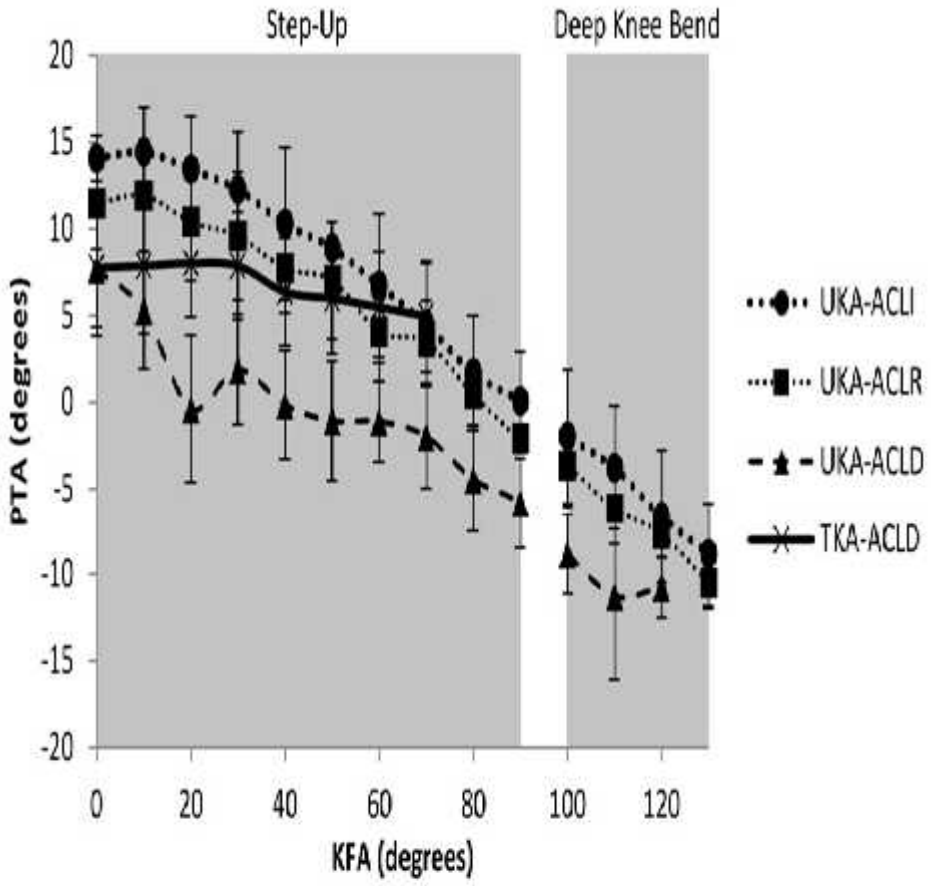

Figure 1. The relationship between the PTA and KFA for UKA-ACLI (n=10), UKA-ACLR (n=10), UKA-ACLD (n=7) and TKA-ACLD (n=14) knees for both the step-up and deep knee bend exercises. Data shown are mean values and the error bars represent the standard deviation.

Discussion: Previous studies have demonstrated that UKA-ACLI and UKA-ACLR knees are not significantly different to a normal knee in terms of the kinematics. The PTA of the UKA-ACLD knees throughout flexion was significantly lower compared with the UKA-ACLI and UKA-ACLR knees, indicating the UKA-ACLD knees have abnormal kinematics. The reduced PTA indicates that the tibia is more anteriorly positioned relative to the femur throughout flexion, this is likely to be due to the ACL not being present, or able, to resist anterior tibial translation. The PTA reduces throughout flexion, which shows that the knee is functioning more normally than the TKA-ACLD knee and may reflect the work by Boissoneault et al. that UKA-ACLD patients can have good outcome. However, the more posterior loading of the tibial tray may explain the increased likelihood of component loosening reported by Goodfellow et al. [1], although further work is required to confirm whether this is the case. In light of this data, it appears that in cases where a patient is ACL-deficient and has medial compartment arthritis, out of all the options examined in this study unicompartmental knee arthroplasty combined with ACL reconstruction will result in the most normal knee kinematics.

Significance: Although ACLD knees that have undergone UKA appear to do well in many cases [2] the results presented here demonstrate significantly different knee kinematics in UKA-ACLD patients, and show that the tibia is more anteriorly positioned. The reduction of PTA with flexion is promising and indicates more normal knee kinematics than a TKA-ACLD knee, but this study shows UKA combined with ACL reconstruction to be the better option for ACLD knees, although this may not be justified in low-demand elderly patients.

Acknowledgments: The authors would like to thank the ARUK for funding this project, Josie Cowell at the Nuffield Orthopaedic Centre for all her help with the fluoroscopy and all the patients who participated.

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