VERIFICATION OF A NOVEL TEST METHOD TO EVALUATE THE EFFECT OF POSTERIOR TIBIAL SLOPE ON THE KINEMATICS OF PCL-RETAINING TKA

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INTRODUCTION

Total knee arthroplasty (TKA) is an effective surgery to treat end-stage osteoarthritis of the knee. However, some post-operative fluoroscopy studies have shown abnormal knee kinematics [1-3] that can lead to suboptimal clinical outcomes [4]. For cruciate retaining (CR) TKA, the posterior tibial slope (PTS) of the reconstructed proximal tibia may play a significant role in restoring normal knee kinematics as it directly affects the tension of the posterior cruciate ligament (PCL) [5,6]. However, when testing the impact of PTS on knee kinematics either by recutting the proximal tibia or by exchanging the tibial insert multiple times, the PCL may become damaged or the soft tissue envelope may become stretched [7]; thus, the study may have inherent flaws that prevent meaningful data to be obtained. The purpose of this study is to verify the reproducibility of a novel method for the evaluation of the effects of PTS on knee kinematics.

MATERIALS AND METHODS

A CR TKA (Optetrak CR, Exactech, Gainesville, FL) was performed using a computer-assisted surgical guidance system (ExactechGPS®, Blue-Ortho, Grenoble, FR) on one fresh-frozen nonarthritic cadaver with an PCL presumed to be intact. Properly sized tibial and femoral components, selected by the guidance system, were implanted using bone cement and assembled with a tibial insert with the thickness of the surgeon's choice. The tibial baseplate was specially designed (Fig. 1) with a mechanism to precisely and easily modify the PTS without the need to repeatedly remove and assemble tibial inserts of varying posterior slopes (as offered by the Optetrak CR system) with the tibial baseplate, potentially damaging the soft-tissue envelope. As part of a separate study protocol, knee kinematics were evaluated by performing a passive range of motion 3 times at each of the 5 PTSs, following the order of 10°, 7°, 4°, 1°, and 10°. The repeatability of the test was investigated by comparing the initial and the last sets of evaluations at 10° PTS. Any deviation found would reflect damage to the soft-tissue envelope or the PCL during the evaluation. The kinematics data from the initial and the last sets were compared at ~0° (3°), 30°, 60°, 90° and 120° flexion, with statistical significance defined as $p<0.05$.

RESULTS

Similar knee kinematics was observed between the two sets of acquisition at 10° PTS (Fig 2). Notably, the anteroposterior (AP) position of the femur relative to the tibia was identical between the three trials performed at the beginning of the experiment and the three trials performed at the very end of the experiment (Fig 2A). No significant differences were found between the two sets of data at the sampled flexion angles, except for a clinically negligible difference found in the femur-tibia AP displacement at 30° flexion ($p=0.04$, difference in means <1mm).

DISCUSSION

The results suggested that the presented test method does not significantly disrupt the soft tissue environment of the knee, therefore provids a reproducible assessment of the knee kinematics with regard to PTS. Previous evaluations of the effect of the PTS on passive knee kinematics often overlooked the potential disruption of the PCL or other soft tissue over the course of aggressive manipulation of the PTS [5,6]. Some soft tissue protecting test method has been proposed for the adjustment of PTS, such as anterior opening wedge osteotomy with gap filling using bone cement [6]. However, the method may not be accurate and can be affected by variability during osteotomy and cement curing. The present study utilized a novel tibial baseplate, which allowed for adjusting the PTS without re-cutting the tibia and removing the components. Knee kinematics can therefore be reliably tested without damage or stretching of the PCL or the soft tissue envelope. As such, the authors promote the proposed test method for future investigations on a larger number of specimens.

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DISCLOSURES

Yifei Dai and Laurent Angibaud are current employees of Exactech Inc.
Amaury Jung and Cyril Hamad are current employees of Blue Ortho SAS.
Jean-Yves Jenny and Michael B Cross are paid surgeon consultants of Exactech Inc.

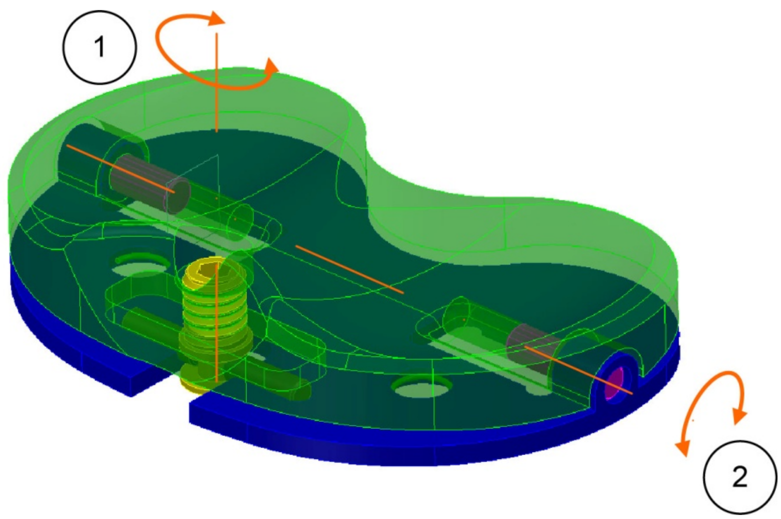

Figure 1: A custom designed tibial baseplate for the test. Turning the anterior screw (1) results in modification of the tibial component posterior slope (2).

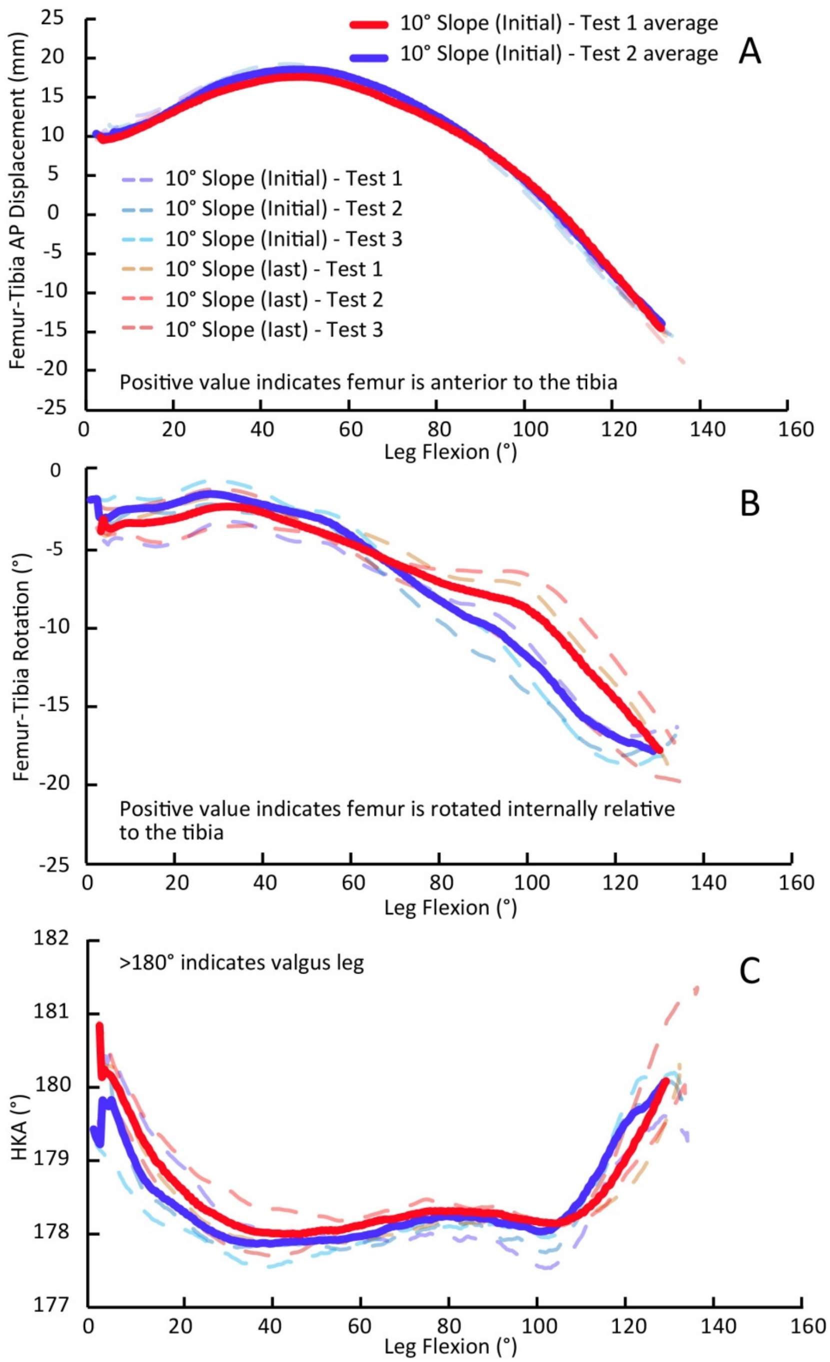

Figure 2: AP position of the femur relative to the tibia (A), IE rotation of the femur relative to the tibia (B), hip-knee-ankle angle (C) as a function of the flexion, compared between the initial and the last acquisitions.