INTRODUCTION

Anatomic placement is critical for successful anterior cruciate ligament (ACL) reconstruction when using either single-bundle or double-bundle (DB) technique. Although most previous study focused on the femoral footprint, native ACL footprints on the tibial side are also widely varied in both sagittal and coronal planes. [1] Specifically, the anteromedial (AM) position is sometimes observed on the lateral side relative to posterolateral (PL) position. In such cases, if the AM bundle is placed on the “anteromedial” position, the AM graft would be placed non-anatomically on the medial side. However, little is known about the effect of the medio-lateral (ML) position for the AM bundle on knee kinematics. Thus, the purpose of this study was to evaluate knee kinematics and in situ force of the ACL after anatomic AM placed and to compare with anatomic PL placement to those with non-anatomic tibial placement. Our hypothesis is that the tibial ML position has a significant effect on knee kinematics and in situ force of the ACL and that tibial anatomic placement restores normal knee kinematics and in situ force of the ACL.

MATERIALS AND METHODS

Eight fresh frozen unpaired mature porcine knees were used in this study. The knees were fixed to a custom-made frame. The tests were performed using the robot (CASPAR Stübbli RN90, OrthoMaquet, Rastatt, Germany) with the universal force-moment sensor (UFS: model 4015, JR3 Inc, Woodland, California) with the universal force-moment sensor (UFS: model 4015, JR3 Inc, Woodland, California). The following external loads were applied to the tibia: 1) a 78 N anterior tibial load at 0° (full extension), 30°, and 60° of flexion; and 2) a combined rotatory load of 7 N-m valgus torque and 4 N-m internal tibial rotation torque at 0°, 10.5°, and 30° of flexion. The same loads were applied to the intact knee, the ACL deficient knee, and the AM reconstructed knee. Knee kinematics and in situ forces of the ACL were recorded. The results are compared among those statuses. The testing protocol is demonstrated in Fig. 1.

Fig 1 Testing protocol

Two types of DB ACL reconstructions were performed. Two 5mm tibial AM tunnels were located at the medial edge of the AM footprint (lateral AM), while the 5 mm PL bundle was created on the center of the footprint. 5mm femoral tunnels for both bundles were then placed in anatomic positions. The 5mm-diameter hamstrings grafts were passed through either medial or lateral AM tunnel and PL tibial tunnel. The fixation on the femur was done by an Endobutton, while on the tibial side with a staple. The AM graft was fixed at 30° of flexion and the PL graft at 60° while applying 20 N tension on each graft. Differences in ATT and in situ force at the different flexion angles were analyzed using Kruskal-Wallis test for comparison of all groups and Mann-Whitney U test between all the pairwise comparisons.

The statistical analysis was done using the software package SPSS version 17.0.

Results

Anterior Tibial load: Anterior tibial translation (ATT) of both the Medial AM and the lateral AM ACL reconstructions were not significantly different from the intact knee at each flexion angle. There were also no significant differences for ATT for both techniques at every testing angle. (Fig 2) In situ force of the native ACL varied from 80.1 ± 10.5 N at 0° of flexion to 88.7 ± 11.39 N at 30° of flexion. At 60° of flexion the AL reconstruction ACL graft had significantly lower in situ force than the native ACL (p<0.05). No significant difference of the in situ forces between the medial AM reconstruction and the lateral AM reconstruction at every testing angle was found. (Fig 3)

Combined rotatory load: Coupled ATT of the Medial AM ACL reconstructed knee and the Lateral AM ACL reconstructed knee were not significantly different from the intact knee. Coupled ATT of the Medial AM reconstruction was not significantly different from the Medial AM reconstruction. (Fig 4) The in situ force of the Medial AM reconstruction ACL graft were lower than the native ACL at each flexion angle. Whereas, the in situ force of the Medial AM reconstruction graft were lower than the native ACL at 0° and higher at 30° of flexion. However there were no significant difference. (Fig 5)

DISCUSSION

This study revealed that both DB ACL reconstruction techniques can restore knee kinematics in response to an anterior tibial load and a combined rotatory load, but the ML position of the AM bundle did not have a significant effect of the both kinematics and ACL in situ force. Although sagittal placement of the graft has been established as an important factor for knee stability, coronal location of the AM bundle might not have such clinical impact. However, the result stems from the porcine knees, which has much wider footprint than human. So further investigation is warranted using human knees.

References