INTRODUCTION

Recent reports [1] have highlighted the importance of anatomical graft placement for restoring kinematics to the knee following anterior cruciate ligament (ACL) reconstruction as a means of reducing the risk of premature osteoarthritis [2]. These reports have provided increasing evidence that guidelines for ACL graft placement should account for individual anatomical variations in the natural position of the ACL. There have been a number of different surgical guidelines that reference anatomical landmarks for determination of tibial tunnel placement based on average population values [3,4]. Morgan et al. suggest tibial tunnel placement at 7 mm anterior to the posterior cruciate ligament (PCL) in all patients [3]. Staubli and Rauschning recommend placement of the tibial tunnel at 44.3% posterior across width of the tibia [4]. However, recent studies have suggested that these normative distances from anatomical landmarks are not necessarily a reliable indicator of anatomic graft position and that these guidelines do not account for the high level of anatomic variability across patients [5].

The purpose of this study was to examine the average anatomical tibial insertion of the ACL in the anterior-posterior direction relative to conventional surgical guidelines [3,4], as well as to test for the range of normal variations in the anatomical position of the ACL by testing the hypothesis that the native ACL tibial insertion is significantly different from the conventional surgical guidelines for tibial tunnel placement.

METHODS

Twenty-seven healthy subjects (12M 15F, 31.8 ± 12.4 yrs) participated in the study after providing IRB-approved informed consent. Sagittal-plane MR images (3D-SPGR, 1.5T) were obtained of both knees of each subject lying in the supine position with legs fully extended and unloaded. The MR images were manually segmented to identify tibial insertions of the ACL, the contours of the PCL and the proximal tibia (Fig. 1). The most anterior margin of the PCL at the level of the superior surface of the medial tibial spine was determined based on the method described by Morgan et al. [3]. The Amis and Jakob line was then created [6], and each anatomical point was expressed in the local tibial coordinate system. A one-sample t-test (α = 0.05) was used to determine significant differences between native tibial ACL insertion position and recommended tibial tunnel placement.

RESULTS

The results supported the hypothesis that the native ACL tibial insertion is significantly different than the surgical recommendations of 7 mm anterior to the PCL and 44.3% posterior on the tibia. The average distance of the ACL insertion from the PCL was 17.9 ± 1.76 mm (p<0.001), range: 15.5-22.3 mm, and 34.2±2.6 % (p<0.001), range: 27.9-40.5% posterior along the Amis and Jakob line.

Fig 1. Image represents most anterior point of PCL measured from medial tibial spine [3], the tibial ACL insertion, and the Amis and Jakob line [6].

Fig 2. Image illustrates population distribution of tibial ACL insertion relative to recommended tunnel placement. Both methods of tibial tunnel placement result in graft placement posterior to anatomic ACL insertion.

DISCUSSION

This study demonstrated that there is indeed a difference between the average tibial ACL insertion and the recommended tibial tunnel placement. This difference was at least 8.5 mm (3.8 %) and as great as 15.3 mm (16.4 %). The large range of native tibial ACL insertion locations indicates that the use of a population average is not ideal as a surgical guideline. Even if the guideline was changed from 7 mm to the population average of 18 mm, there would still be a difference in this population as great as 4.5 mm between the native insertion and tibial tunnel. The results of this study provide further support for the use of the native ACL insertion morphology as a guide for ACL graft placement. The results of the current study also indicate that conventional ACL reconstruction techniques are not successful in placing the graft near the center of the native ACL footprint. This finding is important since nonanatomic graft placement results in altered kinematics [1]. Tibial tunnel placement that is posterior to the anatomic position results in greater graft elevation angle which can fail to prevent internal rotation of the tibia. Complete restoration of kinematics is important because alterations have been linked to premature osteoarthritis in this population [7].

REFERENCES