AN IN-VIVO EXAMINATION OF THE EFFECT OF FEMORAL TUNNEL PLACEMENT DURING ACL RECONSTRUCTION ON TIBIAL ROTATION

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INTRODUCTION

Our recent in-vivo studies have demonstrated abnormal tibial rotation after ACL reconstruction during high demanding activities [Ristanis et al, 2006; Stergiou et al, 2007]. In-vitro studies have supported these findings and examined possible causes for this phenomenon such as the effects of the ACL graft's configuration and placement at the knee [Woo et al, 2002]. They reported that the inability of the ACL reconstructed knee to control rotational loads probably occurs because the commonly used single-bundle surgical procedure places the femoral bone tunnel at the so-called 11 o'clock position for the right knee. This placement replicates the origin of the anteromedial bundle of the ACL, but not the posterolateral bundle, which is important for knee stabilization against rotational loads. Thus, it has been proposed that a more horizontal placement of the graft can address abnormal tibial rotation after an ACL reconstruction. However, this proposition has not been tested with in-vivo studies that can identify how rotational kinematics is affected. Our goal was to investigate the effect of femoral tunnel placement, at (a) laterally and more horizontally at the 10 o'clock position and (b) at the standard 11 o'clock, on tibial rotation after ACL reconstruction with a bone-patellar tendon-bone (BPTB) graft.

METHODS AND PROCEDURES

Twenty patients who underwent an ACL reconstruction with a BPTB graft were randomly assigned in two groups (Group A and B). Group A consisted of ten patients that the femoral tunnel was placed at 10 o'clock, while group B of ten patients where the femoral tunnel was placed at the 11 o'clock. Ten healthy matched subjects formed the control group. Kinematic data were collected (50Hz) with an 8-camera optoelectronic system, while the subjects performed two activities: (1) descend from a stairway and subsequent pivoting, and (2) land from a platform and subsequent pivoting. After foot contact from the descend or the landing, the subjects were instructed to pivot on the landing (ipsilateral) leg at 90º and walk away. Pivoting was performed on both legs. To better analyze our kinematic data, we had a simultaneous recording of the signal describing the key events of the patient's gait cycle with inline foot switches. To further validate our procedures, an additional trial was recorded with the subject in the anatomical position, which was used as the reference for the calculation of the anatomical angles. Based on our hypothesis, the dependent variable examined was the range of motion of tibial rotation during the pivoting period of the two tasks. The selection of the range of motion as the dependent variable eliminated possible errors reported in the literature that used absolute measures (i.e. maximum). A one-way ANOVA was performed on the group means to identify differences between Groups A and B, and the healthy control. Post-hoc analysis was performed if significant differences were identified. Paired t-tests were performed within the two groups to compare the ACL reconstructed leg with the intact.

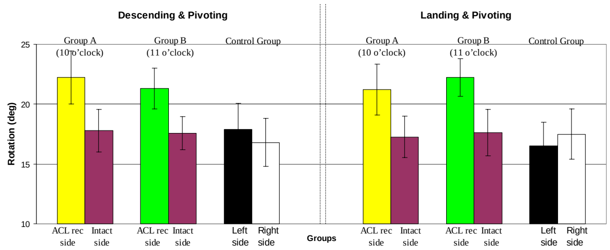

Figure 1. Group means and SDs for range of motion of tibial rotation during the evaluation period for both activities.

RESULTS

Negative Lachman and pivot shift tests, along with KT-1000 results, indicated that the knee joint stability was regained. The one-way ANOVA showed the existence of significant differences among the groups in both examined activities [($F=6.918$; $p=0.003$) for landing and pivoting and ($F=8.948$; $p=0.001$) for descending stairs and pivoting] (Fig. 1). The post-hoc comparisons revealed a) significantly more tibial rotation in the ACL reconstructed leg in both groups and for both activities as compared to the control, b) significantly more tibial rotation in the ACL reconstructed leg within both groups and for both activities as compared with the intact leg c) no significant differences for the ACL reconstructed leg between the two groups.

DISCUSSION

Our results refuted the hypothesis that a more horizontal placement of the femoral tunnel of the BPTB graft during an ACL reconstruction will restore the increased tibial rotation found during dynamic activities that produce higher rotational loads at the knee. It seems that a single-bundle ACL reconstruction placed at either the 10 or 11 o'clock position can not fully restore the complex structure of the ACL and adequately resist dynamic rotational loading. Our results are also supported by an in-vitro investigation by Loh et al [Loh et al, 2003] where it was found that neither femoral tunnel position could completely restore the kinematics and the in situ forces to the level of the intact knee. An alternative solution could be to reconstruct the two bundles separately. Actually, several surgeons have started in the last few years to perform double-bundle reconstructions in order to replicate the exact anatomy of the ACL and solve the problem of abnormal rotational kinematics that also seems to correlate with the initiation of knee degeneration [Asano et al, 2004]. So far only in-vitro studies have reported results of this reconstruction which are very encouraging [Yagi et al, 2007]. However, the superiority of this procedure in restoring abnormal tibial rotation during dynamic activities has not been investigated in-vivo. Furthermore, our results need to be verified for other grafts such as the quadrupled semitendinosus/ gracilis tendon graft.

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