IN-VITRO STUDY OF KNEE LAXITY FOLLOWING POSTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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INTRODUCTION: The posterior cruciate ligament (PCL) is a complex soft tissue structure made up of several bands that play unique roles in the stability and kinematics of the knee.12 Most attention has been paid to the reconstruction of the anterolateral band, but the results of such reconstructions have been inconsistent.1 Controversy exists over what graft tension should be used and at what flexion angle the graft should be tensioned. Also, double-bundle grafts mimicking both the anterolateral and posterolateral bands of the PCL have been proposed for PCL reconstruction,2 but the effectiveness of these techniques is as yet uncertain. The purpose of this study was to compare the anterior/posterior (A/P) joint laxity following three PCL reconstruction techniques: a single, anterolateral, bundle technique, a combined, anterolateral/posteromedial, double bundle technique, and a single, anterolateral, bundle technique in which the joint was reduced in extension and the graft was tensioned in deep flexion. We hypothesized that the latter technique would provide superior restoration of normal neutral position and A/P laxity in comparison to those provided by the other techniques.

METHODS: The Achilles and posterior tibial tendons were harvested from seven, fresh, human, lower extremity cadaveric specimens. Each specimen was then mounted, by rigid fixation of the femur, onto a test stand that incorporated a 3-axis load cell and an instrumented spatial linkage (ISL). The free end of the ISL was attached to the tibia. The A/P laxity of the knee at various angles of flexion was examined for the following knee states: 1) Intact-Normal; 2) PCL and posterior lateral corner structures (including the LCL) cut; 3) Single anterolateral bundle PCL reconstruction using an Achilles tendon graft tensioned at 90° of flexion with the tibia anteriorly displaced; 4) Single anterolateral bundle PCL reconstruction using an Achilles tendon graft tensioned at 90° of flexion with the tibia anteriorly displaced; 4) Single anterolateral bundle PCL reconstruction using an Achilles tendon graft where the joint was reduced in extension followed by graft tensioning at 120° of flexion; and 5) Combined, anterolateral/posteromedial, double bundle PCL reconstruction using Achilles and posterior tibial tendon grafts with both grafts tensioned separately at 90° of flexion.

ANOVA, followed when necessary by post priori Tukey HSD tests (p<0.05), was used to statistically assess differences among the knee conditions.

RESULTS: When the PCL was cut, the neutral position of the tibia moved posteriorly, relative to its intact position, by as much as 9 mm at 90° of flexion, Figure 1. The single anterolateral bundle reconstruction with the graft tensioned at 90° restored the normal neutral tibial position throughout the range of motion. However, the double bundle reconstruction and the single, anterolateral, bundle reconstruction tensioned in deep flexion resulted in as much as 4 mm of anterior tibial subluxation. The anterior limit of knee laxity was not significantly altered by the cutting of the PCL nor by the subsequent reconstructions except when the graft was tensioned in deep flexion. In the latter case, significantly greater (P<0.05) anterior laxity was seen at 30° and 90° of flexion. All the reconstruction techniques reduced the abnormally large posterior laxity, created by the cutting of the PCL, to levels that did not differ from normal. The double tunnel reconstruction most closely mimicked the posterior laxity profile of the intact knee, Figure 2.

DISCUSSION / CONCLUSION: In general, all of the reconstruction techniques tested provided adequate restoration of normal anterior/posterior knee laxity. While attractive for its attempt to mimic the normal anatomy, the double-bundle technique used in this study not only did not statistically surpass the single bundle reconstructions in restoration of normal laxity, but also created abnormal anterior subluxation of the tibial neutral position. The technique tested that involved joint reduction in extension prior to graft tensioning and fixation deep flexion avoided arbitrary anterior tibial displacement during graft fixation, but also resulted in abnormal anterior subluxation of the tibial neutral position. The results of this study did not support the hypothesis that this latter technique provided superior restoration of joint position and laxity in comparison to the other tested techniques. The restoration of joint position and laxity provided by the single, anterolateral, bundle PCL reconstruction technique, with its arbitrary anterior tibial displacement, was not surpassed by those of the other techniques tested.

FIGURE 1: Tibial Neutral Position

FIGURE 2: Tibial Displacement at 86 N of Posterior Force

References


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