A BIOMECHANICAL STUDY OF GRAFT FORCES FOLLOWING RECONSTRUCTION OF THE ACL-PCL DEFICIENT KNEE

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Introduction: Results of combined ACL-PCL reconstructions are not as satisfactory as those for isolated ACL deficiencies. Surgeons performing combined cruciate reconstructions have noted that it is often difficult to restore normal anterior and posterior tibial translation at surgery, and residual laxity (usually posterior) is often present at follow-up. This observed posterior laxity could contain a component of excessive anterior laxity as well, since there are no defined end-points to serve as references from which anterior and posterior tibial translations can be measured. Regardless of which cruciate reconstruction may be responsible for the observed laxity, graft stretch-out could be related to excessive graft forces. This in turn could be related to an improper combination of graft pretensions applied at the time of surgery. The purpose of this study was to compare graft forces in combined ACL-PCL reconstructions with those of their native cruciate counterparts, and to study the effects of overtensioning one graft while fixing the pretension of the opposing graft to a nominal level.

Methods: Twelve fresh-frozen cadaveric knee specimens were instrumented with load cells to record forces at the tibial insertion of the ACL and at the femoral origin of the PCL as the knees were extended from 120° to -5°. ACL-PCL reconstructions were performed using B-PT-B allografts and through a process of trial and error, levels of graft pretensions were found which best restored AP laxity between 0° and 90°; these were referred to as the nominal ACL and PCL graft pretensions. After experimenting with various pretensioning strategies, the final protocol selected was to pretension both grafts with the knee at 30° (PCL pretensioned first). The mean nominal pretension for the PCL was 21.3N (sd 19.2) and for the ACL 9.4N (sd 3.8). Graft forces during the flexion cycle were measured at nominal ACL and PCL graft pretensions, and also with one graft at its nominal pretension and the opposing graft pretensioned to 40 N above its nominal level. An ANOVA with repeated measures was used to compare graft forces to native counterparts, and to compare graft forces resulting from overtension conditions. The level of significance was p < 0.05.

Result: ACL graft forces were not significantly different from native ACL forces over the flexion range:

Discussion: At the nominal graft pretension levels used in this study, ACL graft forces were not significantly different than those for the native ACL. This was not the case for the PCL graft, where forces were higher than the native PCL in hyperextension and from 50-85°. These higher PCL graft force levels could be responsible for the increased posterior laxity observed in some patients undergoing this procedure. Overtensioning an ACL graft significantly increased its force level from -5° to 110°; an overtensioned PCL graft demonstrated the highest force near full extension, while an overtensioned PCL graft demonstrated the highest force near 0° and 90°. The relationships between graft pretension and graft forces are complex for dual cruciate reconstructions, and we were unable to find graft pretension levels which produced normal force profiles for both grafts.

Overtensioning the ACL graft by 40 N significantly increased ACL graft forces at flexion angles less than 110°; overtensioning the PCL by 40N had no significant effect upon ACL graft forces:

Overtensioning the PCL graft by 40 N significantly increased PCL graft forces over the entire flexion range; overtensioning the ACL graft by 40 N significantly decreased PCL graft force at -5° and beyond 95° degrees: