Introduction: The normal ACL consists of the anteromedial (AM) and posterolateral (PL) bundles, each having different functions. Recently, authors reported the first clinical procedure for ‘anatomic’ double-bundle ACL reconstruction, in which they defined this procedure as involving transplantation of the 2 tendon grafts at the center of the anatomic attachment of the AM and PL bundles, respectively, in both the tibia and the femur.[1] Thereafter, based on the anatomic double-bundle concept, recent research has focused on the diagnosis and treatment of symptomatic ‘partial’ ACL tears with the use of individual arthroscopic reconstruction.[2,3,4] Recently, Siebold et al reported an isolated reconstruction of the AM or PL bundle while preserving the ‘intact’ bundle of the ACL. However, the influence of isolated deficiency of the AM or PL bundle of the ACL on the resulting knee kinematics is not well understood. The purpose of this study was to evaluate knee kinematics after isolated tear of AM or PL bundle.

Methods: Fourteen fresh-frozen cadaveric knees were used. The knee was mounted in a 6 degree of freedom rig and laxity testing was performed using the following: 90-N anterior tibial loads, 5-Nm internal and external tibial torques, and simulated pivot-shift test (50N-iliotibial traction, 5-Nm valgus moment, and 1-Nm internal tibial torque). Knee kinematics during flexion-extension cycles were recorded with an active optical tracking system (Polaris, NDI, Canada) for (1) the intact, (2) isolated AM bundle tear (n=7) or (3) isolated PL bundle tear (n=7), and (4) the ACL-deficient. Distance between the femur and the tibia with the surface fibrous structure of the ACL. Next, AM and PL bundles of the ACL were identified, and were then separated by a blunt probe between the two bundles. Then, the AM bundle or the PL bundle was transected at the midsubstance portion to simulate an isolated AM or PL bundle tear. The kinematic data were analyzed by using a two-way repeated-measures analysis of variance. Significance was set at p<0.05.

Results: Knee kinematics: The anterior translation-versus-flexion curves were significantly different among the ACL-deficient, the AM, and the PL bundle tears (p<0.0001) (Fig. 1). The anterior translations in the AM bundle tear were significantly greater than in the PL bundle tear at near flexion position. The difference value between the intact and partial tears was less than 3 mm. The internal rotation-versus-flexion curves were significantly different among the ACL-deficient, the AM, and the PL bundle tears (p<0.0001) (Fig. 2). There was a significant difference (p<0.0001) between the AM and the PL bundle tears. The difference value between the intact and partial tears was less than 1.5 degrees. Transection of the ACL did not cause significant change in tibial external rotation laxity. Under the simulated pivot-shift test, tibial anterior translation increased significantly (p<0.0001) after the ACL was sectioned. The anterior translation-versus-flexion curves were significantly different among the ACL-deficient, the AM, and the PL bundle tears (P<0.0005). There was a significant difference (p=0.0001) between the AM and the PL bundle tears. Distance between the femoral and the tibial attachment of the PL and AM bundles: Under anterior tibial load, the AM and PL distances increased significantly at all flexion angles after the both bundles were sectioned. (Fig. 3, 4) The AM bundle distance increased significantly more after AM bundle tear than after PL bundle tear in flexion. Regarding the PL distance, there were no significant differences between the intact and the PL bundle tears. Discussion: This study showed that anterior translation laxity under anterior tibial load, rotational laxity under tibial torque and anterior translation laxity under pivot-shift loading were significantly different between the AM and the PL bundle tear. However, the difference between the intact and both partial tears was less than only 3 mm or 1.5 degrees. In addition, there were no significant differences between the intact and the PL bundle tears concerning the PL bundle distance under anterior tibial load. Linter et al reported that arthrometer testing detected no difference between intact and isolated AM bundle sectioned. Hole et al reported that instrument testing showed a statistically insignificant 0.6mm increase in anterior translation after sectioning of the PL bundle. Therefore, if the surviving bundle is ‘intact’, partial tears of AM or PL bundle may not cause a clinically measurable increase of laxity. This suggests that the clinical diagnosis of a partial tear of the ACL is more likely to represent a ‘functionally complete tear’. This might suggest that there is no justification for using partial reconstruction, and so further understanding of the clinical and biomechanical performance is required.


Fig. 1 Increase of the anterior translation over the intact under 90-N anterior tibial load (Mean(SD))

Fig. 2 Increase of the internal rotation over the intact under 5-Nm internal tibial torque (Mean(SD))

Fig. 3 Distance between the femoral and the tibial attachment of the AM bundle under anterior tibial load (Mean(SD))

Fig. 4 Distance between the femoral and the tibial attachment of the PL bundle under anterior tibial load (Mean(SD))