Biomechanical Comparisons between 4-strand Anatomic and Modified Larson’s Procedures for Posterolateral Corner Reconstruction

Introduction: The posterolateral corner (PLC) resists varus rotation, external tibial rotation, and, to a lesser extent, posterior tibial translation. Several biomechanical studies have shown the lateral collateral ligament (LCL), popliteus tendon (POP), and popliteofibular ligament (PFL) to be the most important stabilizing structures of the posterolateral knee [1]. PLC injuries are associated commonly with posterior cruciate ligament (PCL) injuries [2]. It is important that reconstruction of posterolateral knee injuries would also ultimately result in restoration of objective motion, stability and patient function. There are few studies of kinematics for anatomic PLC reconstruction [3,4]. The Larson’s reconstruction is commonly used, but is not an anatomic procedure [5,6]. We have developed a new 4-strand anatomic PLC reconstruction. We hypothesized that our anatomic PLC reconstruction would give better stability to external rotatory and varus load than Larson’s reconstruction.

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 following [5]: 90-N anterior and posterior tibial loads, 5-Nm internal and external tibial torques, and 5-Nm varus moment. Knee kinematics were recorded with an active optical tracking system (Polaris, ND, Canada) for the intact, PLC-deficient, modified Larson’s PLC reconstructed and anatomic PLC reconstructed knees. PLC reconstruction was performed twice in each knee by filling the tunnels with polyester resin using the same hamstring tendon (TI-CRON, USA).

Our 4-strand anatomic PLC reconstruction is shown at Fig.1-a. A tunnel was drilled through the fibular head from the attachment of the LCL to the attachment of the PFL. A tibial tunnel was drilled to the posterior popliteal tibial bone, with the isometric point beside Gerdy’s tubercle. The femoral tunnels were drilled at the POP and the LCL attachments. The semitendinosus graft was passed through both the tibial and fibular tunnels as PFL and POP. The gracilis graft (dark gray in Fig 1a) passed through the fibular tunnel as LCL and PFL. The ends of the grafts were passed through these tunnels and tensioned independently by means of custom-made adjustable screws and EndoButtons, to which the leading sutures were tied, on the medial condyle. Both tendon grafts were passed through the fibular tunnel and fixed there with an Arthrex interference screw. The LCL graft was tensioned progressively at 20° flexion to match the laxity of the intact knee subjected to a varus moment of 5-Nm. The POP graft was tensioned progressively at 90° to match the laxity of the intact knee subjected to an external rotation torque of 5-Nm. The modified Larson’s PLC reconstruction was performed with the semitendinosus tendon [6] (Fig.1-b). The graft was passed through the fibular tunnel and the middle part of the graft was fixed there with the interference screw. Both the anterior and the posterior limbs of the graft were held together and the isometric point was located on the femur while the knee was flexed and extended from 0 to 90°. Two tunnels were drilled from the isometric point, each exiting at a different point on the femoral cortex. The anterior and posterior limbs of the graft were tensioned independently in the same manner as before.

The kinematic data were analyzed by using a two-way repeated measures analysis of variance. Significance was set at p<0.05.

Results: With external tibial torque, the external rotation-versus-flexion curves were significantly different between the PLC-deficient, the modified Larson’s and anatomic reconstruction (p<0.0001) (Fig. 2). The rotational laxity in anatomic reconstruction was significantly less than in the PLC-deficient (p=0.0001) and modified Larson’s reconstruction (p=0.0112). In response to posterior load, the coupled external rotation-versus-flexion curves were significantly different among the 3 groups (p<0.0001) (Fig. 3). The coupled external rotation laxity in modified Larson’s and anatomic PLC reconstruction were significantly less than in the PLC-deficient (p=0.0484, P=0.0020). There was no significant difference of coupled external rotation between the modified Larson’s and anatomic PLC reconstructions (P=0.2102). The varus rotation-versus-flexion curves were significantly different between the PLC-deficient, the modified Larson’s and anatomic reconstruction (p<0.0001) (Fig. 4). The varus laxity was not significantly different between the modified Larson’s and anatomic reconstruction (P=0.7080).

Discussion: This study showed that the rotational knee laxity in response to both external rotation and posterior translation tibial load were significantly better after the anatomic PLC reconstruction than after the modified Larson’s reconstruction, although there were no significant differences between the two procedures concerning the anterior tibial loads, internal rotation tibial torques and varus moment. Anatomic PLC reconstruction may produce a better biomechanical outcome, especially during external rotation and posterior translation (drawer) tibial load. We suggest that this relates to load-sharing among the four graft strands crossing the joint.

Fig. 1 a. Anatomic PLC recon. b. Modified Larson’s recon.
Fig. 2 Increase of rotation over intact under 5-Nm external rotation (mean (SD), n=14)
Fig. 3 Increase of the coupled external rotation over intact under 90-N posterior load (mean (SD), n=14)
Fig. 4 Increase of varus rotation over intact under 5-Nm varus loading (mean (SD), n=14)