

Graft Fixation Sequence in One-Stage Anterior Cruciate Ligament and Posterior Cruciate Ligament Reconstruction

Libin Zheng, MD, CHINA

Soheil Sabzevari, MD, UNITED STATES

Brandon D. Marshall, MS, UNITED STATES

Junjun Zhu, BS, MS, UNITED STATES

Monica Linde, BS, RN, UNITED STATES

Patrick J. Smolinski, PhD, UNITED STATES

Freddie H. Fu, MD, UNITED STATES

Department of Orthopaedic Surgery, University of Pittsburgh
Pittsburgh, PA, UNITED STATES

Summary:

According to the results of this study, the best fixation sequence for combined ACL/PCL reconstruction is when the ACL graft fixed first at close to full extension followed by the PCL graft fixation.

Abstract:

Introduction: There is no consensus regarding the best protocol for the sequence of graft tensioning and fixation in one-stage reconstruction of combined anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL). This study sought to determine the effect of ACL/PCL graft tensioning and fixation protocol on knee biomechanics. It is hypothesized that the sequence to best restore intact knee kinematics and the intact tibial position will be the ACL graft fixed first at close to full extension and the PCL graft fixed second with the knee flexed.

Methods: Twelve fresh-frozen mature porcine hind limbs (n=12) were used. The knees were tested using a robotic testing system with a universal force-moment sensor. One-stage, combined anatomic single bundle (SB) ACL and PCL reconstructions were performed with and 8 mm grafts from bovine extensor tendon. The knee states tested were: (1) intact ACL and intact PCL, (2) deficient ACL and deficient PCL, and (3) one-stage ACL and PCL reconstruction. Five fixation sequences were performed in each knee in a randomized order: (1) PCL fixed 1st at 30° and ACL fixed 2nd at 30° (Recon 1), (2) PCL fixed 1st at 90° and ACL fixed 2nd at 30° (Recon 2), (3) ACL fixed 1st at 30° and PCL fixed 2nd at 30° (Recon 3), (4) ACL fixed 1st at 30° and PCL fixed 2nd at 90° (Recon 4) and (5) ACL and PCL fixed simultaneously at 30° (Recon 5). Both grafts were tensioned to 40 N. Two external loading conditions were tested: an 89 N anterior tibial and a posterior tibial load at 30° (full extension in the porcine knee). A 3-dimensional digitizer was used to measure the anterior-posterior (A-P) shift of the tibia in each of the reconstructed knee positions from the intact knee position in the unloaded knee. Data was analyzed using one-way repeated measures ANOVA, and statistical significance was set at $p < 0.05$.

Results: None of the reconstructions restored the range of A-P translation to that of the intact knee at 30° of flexion, where the A-P translation is the sum of the anterior tibial translation (ATT) and posterior tibial translation (PTT). The mean A-P translation was: 7.9 ± 1.3 mm at intact ACL and PCL, 16.4 ± 3.7 mm at deficient ACL and PCL, 12.3 ± 2.2 mm at Recon 1, 12.1 ± 3.2 mm at Recon 2, 12.8 ± 3.3 mm at Recon 3, 13.5 ± 2.6 mm at Recon 4, and 13.1 ± 2.6 mm at Recon 5. The mean anterior shift was: 2.69 ± 1.41 mm in Recon 1, 2.73 ± 2.88 mm in Recon 2, 0.05 ± 0.60 mm in Recon 3, 0.44 ± 1.27 mm in Recon 4, and 1.02 ± 1.39 mm in Recon 5.

Conclusion: From the results of this study, if the PCL graft is fixed first the tibia will shift anteriorly regardless of flexion angle of the knee. However, while the knee is at full extension (30° in the porcine knee), fixation of the ACL graft first only causes a smaller shift of the tibia. Thus, the ACL graft should be fixed first while the knee is at full extension, and then the PCL graft can be fixed at either a low or high flexion angle. While fixation of the ACL graft

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first at 30° of flexion does not cause a large shift of the tibia, the A-P translation is not restored by any of the five fixation sequences.