Extra-articular Tenodesis Contributes to Knee Stability with a Combined ACL and Capsular Injury
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INTRODUCTION: Recent meta-analyses have concluded that current ACL reconstruction methods fail to restore normal knee function [1]. In addition, the "gold standard" treatment of anterolateral capsule-injuries with anterior cruciate ligament (ACL)-deficient knees has not been determined, but might include an extra-articular tenodesis at the time of ACL surgery [2]. Quantitative evaluation of rotatory stability of intra- and extra-articular reconstructions in combined ACL/anterolateral capsule-deficient knees has not been performed. The purpose of this study was to determine the effects of ACL reconstruction and extra-articular reconstruction on joint motion in the ACL deficient and in the combined ACL/anterolateral capsule-deficient knee.

METHODS: Seven fresh-frozen cadaveric knees (mean age 53.7 years, range 46-59 years) were tested using a robotic testing system (MJT Model FRS2010, Chino, Japan). The femur was rigidly fixed relative to the lower plate of the robotic testing system and the tibia was attached to the upper end plate of the robotic manipulator through a 6-degree-of-freedom universal force/moment sensor (UFS, ATI Delta IP60 SI-660-60, Apex, NC). Two loading conditions were applied to each knee and the resulting joint motion was recorded. The loading conditions were: 1) anterior tibial load of 134 N and 2) internal tibial torque of 7 Nm. The five knee states were: 1) intact knee, 2) ACL-deficient knee, 3) ACL-reconstructed knee, 4) combined ACL deficient/anterolateral capsule injured knee, and 5) reconstructed combined injured knee (isolated ACL reconstruction versus combined intra- and extra-articular reconstruction using gracilis tendon autograft). Since the tests were conducted within the same knee specimen, statistical analyses were performed using a repeated one-factor ANOVA with multiple contrasts to analyze the variations of the in situ forces at 30°, 60°, and 90° of knee flexion; significance was set at p < 0.05.

RESULTS: In response to an anterior tibial load with the knee at 30°, 60° or 90° of flexion, anterior tibial translation (ATT) following ACL reconstruction was not statistically different from the intact knee. A combined ACL and anterolateral capsule injury increased ATT by 14.8 mm, 16.2 mm, and 14.1 mm at 30°, 60°, and 90° of flexion, respectively. When a combined ACL and anterolateral capsule injury was present, the ATT was decreased by 12 mm, 13.2 mm, and 11.7 mm, when only an isolated ACL reconstruction was performed. A combined intra- and extra-articular reconstruction did not further decrease ATT significantly. (Image 1a). Under an internal tibial torque of 7 Nm with the knee in 30°, 60° and 90° flexion an isolated ACL reconstruction was not statistically different from the intact knee for internal rotation (IR). A combined ACL and anterolateral capsule injury increased IR by 5.4°, 6.5°, and 6.2° at 30°, 60°, and 90° of flexion, respectively. When a combined ACL and anterolateral capsule injury was present with the knee in 30° flexion an isolated ACL reconstruction decreased IR by 1.6°. A combined intra- and extra-articular reconstruction did not further decrease IR significantly With the knee at 60° or 90° of flexion an isolated ACL reconstruction in a combined ACL and anterolateral capsule injury decreased IR by 1.1° and 0.8°, respectively. A combined intra- and extra-articular reconstruction decreases IR by additional 4.2° and 4.3°, respectively. (Image 1b). Additionally, two out of seven specimens showed overconstraint IR of the joint after a combined intra- and extra-articular tenodesis was performed compared to the intact joint.

DISCUSSION: The most important finding of our study is that in higher flexion angles an extra-articular tenodesis adds significant rotational stability over an ACL reconstruction alone in a combined ACL and anterolateral capsule deficient knee. Based on the current literature, intra-articular ACL reconstructions are effective in limiting anterior translation compared with the normal knee when anterior loads are applied to the tibia relative to the femur [3]. However, they were not as effective in reducing joint motion when the joint was subjected to internal tibial torques [4]. Our data suggests, that in some cases an extra-articular tenodesis might be a component of the treatment plan. Future studies should direct quantification of rotatory instability correlated with the pattern of injury. In this way the surgeon can adapt the operative procedure based on the instability.

SIGNIFICANCE: In a combined ACL/anterolateral capsule injured knee an extra articular tenodesis should be considered as a potential component of the treatment plan.


IMAGES:

![Image 1](image1.png)

Image 1: Kinematics of the particular states at the respective flexion angles in response to (a) 134 N anterior tibial load and (b) 7 Nm internal rotation torque. Blue = Intact. Red = Anterior cruciate ligament (ACL)-deficient + Anterolateral capsule (ALC) cut. Green = ALC cut + ACL-reconstructed. Violet = ALC cut + ACL-reconstructed + Extra-articular tenodesis. (*p<0.05).