

Biomechanical Analysis of a Dual-Docking, Four Ply, Medial Ulnar Collateral Ligament Reconstruction Technique

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Disclosures: S.J. Ingwer (3A - Arthrex, Inc.), O. Hauck (3A - Arthrex, Inc.), A. Bitzer- none, P. Connor (1 - Integrity Orthopaedics, Lima Corporate, 3B- Arthrex, Inc., 5- Lima Corporate, Arthrex, Inc., 9 - OrthoCarolina Research Institute, Past Chairman of the Board, Board Member, NFL Physicians Society, Past-President, Emeritus, Executive Board Member).

INTRODUCTION: Ulnar collateral ligament reconstruction has evolved greatly since the creation of the Jobe graft loop technique. One major limitation of this foundational technique was post-operative failure of the ulnar bone bridge and reoccurring midsubstance tears. To address these issues, various reconstruction techniques have been published utilizing single ulnar bone tunnel suspensory fixation and various strength-enhancing elements such as suture tape augmentation. The purpose of this study was to investigate the biomechanical efficacy of a reconstruction technique with suture tape augmentation and a novel double-looped graft technique (Augmented 4-ply) and to compare to more traditional reconstruction techniques.

METHODS: An ElectroPuls[®] mechanical testing device (Instron, Norwood, MA) was used to investigate the biomechanical performance of 12 pairs of cadaveric elbow specimens (n=24). 12 specimens were randomly selected for the double-looped graft group (4-ply). The remaining matched alternate elbow specimens were assigned either the single-looped graft group (2-ply) or Augmented 4-ply group. Post preconditioning (10 cycles of 0.2Nm-2 Nm), valgus cyclic torsional testing (2-10Nm for 250 cycles) of native and reconstructed specimens was done at 90° of elbow flexion with allowable joint extension via ulnar/radial translation. Reconstructed specimens continued to a torque to failure phase. Outcomes included cyclic stiffness, cyclic rotational displacement, gap formation and ultimate strength. One-way ANOVA was used to evaluate significant effects of all biomechanical variables. If significance was observed, post-hoc comparisons were performed with either Holm-Sidak test or Dunn's Method test (SigmaPlot 14.0, Systat). IRB approval was not required due to de-identified cadaveric specimens used.

RESULTS SECTION:

Cyclic stiffness was greatest for the Augmented 4-ply group, followed by 4-ply, Native, and 2-ply (4.72 Nm/deg±1.0Nm/deg, 4.4Nm/deg±0.7Nm/deg, 4.3Nm/deg±0.7Nm/deg, 3.7Nm/deg±0.5Nm/deg, respectively). Cyclic stiffness of the Augmented 4-ply group and 4 ply was not statistically different from Native (p=0.571, 1.00, respectively). Amongst the reconstructed groups tested to failure, the Augmented 4-ply showed the greatest strength, followed by 4-ply, and then 2-ply (46.2Nm±12.5Nm, 45.9Nm±36.0Nm, 30.9Nm±6.7Nm, respectively). Significance of ultimate load values was only detected when comparing Augmented 4-ply to 2-ply (p=0.03). Gap formation and cyclic rotational displacement revealed insignificant findings. Primary failure modes include graft stretch for the 2-ply group (3/6), button loop loosening for 4-ply group (7/12), and equal parts button loop loosening, suture tearing, and humeral cortex blowout for Augmented 4-ply group (2/6 for each mode of failure).

DISCUSSION: Results of this biomechanical investigation suggested that the Augmented 4-ply reconstruction restores cyclic stiffness to native function as well as optimizes resistance to torsional loading compared to other groups. Clinically, these outcomes may translate to expedited return to play, optimized post-operative rehabilitation, and reduced injury reoccurrence. Limitations for this study include that this is a time zero study that analyzed outcomes biomechanically, which cannot simulate the biomechanical performance of reconstruction with healing and rehabilitation practices.

SIGNIFICANCE/CLINICAL RELEVANCE: This study found that that a double looped graft fixation technique with suture augmentation results in a more robust reconstruction and may be a suitable option for patients with little support by native tissue. Future reconstruction techniques may utilize the use of suture in what previously would have been allograft alone.

IMAGES AND TABLES:

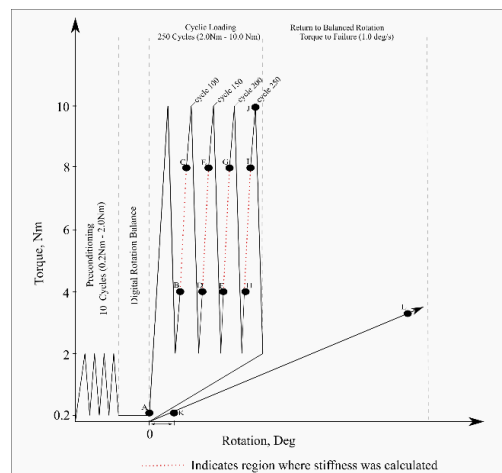


Figure 1: Biomechanical Testing Sequence

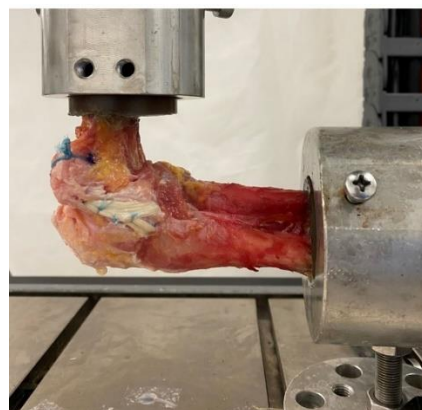


Figure 3: Cadaveric elbow and fixated at 90° flexion for torsional testing