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Effects of combined anterior and posterior plication of the glenohumeral ligament complex for the repair of anterior glenohumeral instability: a biomechanical study

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Background: Arthroscopic repair techniques for anterior instability most commonly address only the anterior band of the inferior glenohumeral ligament. This study quantitatively evaluated and compared the combined anterior and posterior arthroscopic plication by repairing both the anterior and posterior bands of the inferior glenohumeral ligament with the anterior arthroscopic plication alone.
Materials and methods: Six cadaveric shoulders were tested in 60° of glenohumeral abduction with 22 N of compressive force in the coronal plane for intact, after anterior capsular stretching, after anterior repair, and after posterior arthroscopic repair. Range of motion, glenohumeral translation, and glenohumeral kinematics throughout the rotational range of motion were measured with a MicroScribe 3DLX (Immersion, San Jose, CA, USA). Glenohumeral contact pressure and area were measured with a pressure measurement system (Tekscan Inc, South Boston, MA, USA).
Results: Stretching the anterior capsule significantly increased external rotation and anterior translation ($P < .05$). After anterior plication, external rotation was restored to the intact condition, and anterior translation was significantly decreased compared with stretched condition ($P < .05$). The combined anterior and posterior plication significantly decreased internal rotation compared with the intact condition. The anterior plication shifted the humeral head posterior in external rotation, whereas the combined anterior and posterior plication shifted the humeral head anterior in internal rotation ($P < .05$). Both repairs led to a decrease in glenohumeral contact area at 45° external rotation ($P < .07$).
Conclusions: The addition of a posterior plication to anterior plication for anterior instability has no biomechanical advantage over a typical arthroscopic anterior repair for anterior glenohumeral instability.
Level of evidence: Basic Science Study.

Keywords: Anterior instability; arthroscopic repair; glenohumeral translation; range of motion

This investigation was performed at the Orthopaedic Biomechanics Laboratory, VA Healthcare System, Long Beach, and at the University of California-Irvine, Irvine, California, USA.
Investigational Review Board approval was not required for this basic science study.

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The inferior glenohumeral ligament complex has been described as an identifiable complex consisting of discrete anterior and posterior bands with an interposed axillary pouch.[13] The extent of injury of the entire inferior glenohumeral ligament complex is known to play a role in glenohumeral instability and may contribute to surgical failure if not treated. Biomechanical studies of glenohumeral dislocations in cadaveric specimens found that the creation of a Bankart lesion alone was not able to create a dislocation of the joint.[16,19] Instead further capsular damage was necessary to produce a significant increase in laxity.

Pouliart et al[16] found that extension of the labral injury must extend either posterior or superior, or involve capsular stretching, midsubstance capsule tears, or a fracture. When addressing this pathology arthroscopically, additional repair beyond anterior plication could be added to address these lesions. Although there may be a role for extending the area of repair used for typical anterior instability, the effects of the additional repair on glenohumeral biomechanics have not been studied.

One of the benefits of arthroscopic repair is the ability to evaluate the entire glenohumeral joint at the time of repair. Capsular redundancy has been reported in revision cases of failed anterior stabilization procedures.[11,20] These studies suggested a larger capsular plication for the treatment of anterior instability. Other authors have used both an anterior and posterior capsulorrhaphy in the treatment of anterior shoulder instability to address the issue of capsular laxity.[24] They report a low recurrence rate, but also note a loss of motion in a number of patients. This study used a cadaveric model to quantitatively evaluate and compare the combined anterior and posterior arthroscopic plication by repairing both the anterior and posterior bands of the inferior glenohumeral ligament with the anterior arthroscopic plication alone on glenohumeral translation, rotational range of motion, glenohumeral kinematics, and glenohumeral contact pressure.

Materials and methods

The study used 6 fresh frozen shoulders from deceased donors who were an average age of 65.6 years. All specimens had no evidence of rotator cuff tears, glenohumeral stiffness, or arthropathy. Each specimen was dissected down to the glenohumeral capsule, with the rotator cuff muscles removed at the musculotendinous junction. Three screws were placed on the scapula at the coracoid, anterior acromion, and posterior acromion, and 3 screws were placed on the humerus at the proximal bicipital groove, distal bicipital groove, and greater tuberosity.[8] The humerus was fixed in a polyvinylchloride pipe with plaster of Paris. The scapula was trimmed and potted in a custom box, with the glenoid parallel to the top of the scapular box and the superior−inferior and anterior−posterior axes aligned with the width and height of the box.

A custom shoulder testing system was used that permits for 6 degree-of-freedom positioning of the glenohumeral joint (Fig. 1).

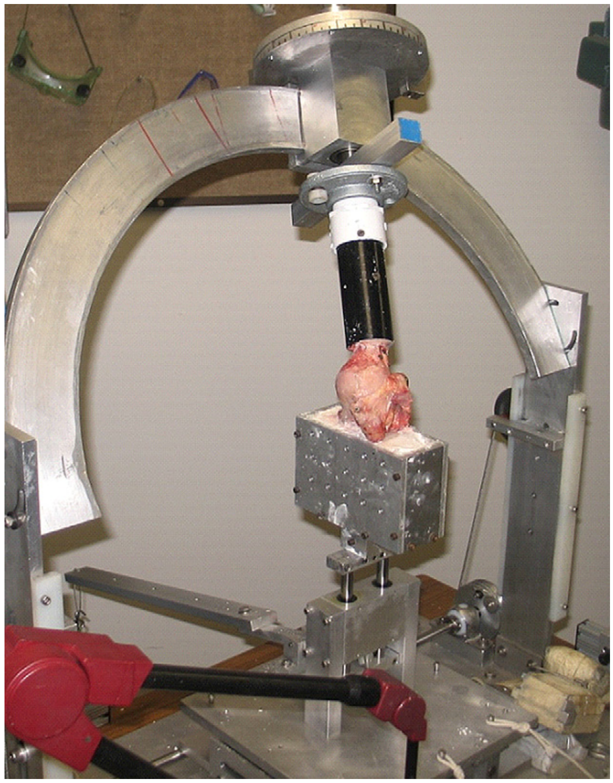

Figure 1 Photograph shows the custom-designed testing system.

The scapular box was mounted onto a vertical linear bearing translator and lever arm system on top of 2 translation plates that allowed anterior−posterior and superior−inferior translation. The humerus was attached to an arc at the top of the testing system that allowed humeral rotation, abduction, and horizontal adduction. A compressive force of 22 N was applied throughout each testing condition through the vertical linear bearing translator and lever arm system. All testing was performed in 60° glenohumeral abduction with the humerus extended (horizontally abducted) 20° from the scapular plane, simulating the coronal plane. During dissection and testing, the specimens were kept moist with normal saline.

Biomechanical measurements

Rotational range of motion was measured with 1.1 Nm of torque applied using a goniometer that was attached to the testing system at the distal humerus. Before measuring, each specimen was preconditioned by applying 1.1 Nm of torque for 10 cycles. Glenohumeral kinematics were recorded throughout the rotational range of motion by digitizing the local coordinate systems with a MicroScribe 3DLX (Immersion, San Jose, CA, USA) at positions of maximum internal rotation, 45° external rotation, 90° external rotation, and maximum external rotation.

Glenohumeral translation in the anterior, posterior, inferior, and superior directions was measured with 20-N and 25-N translational loads. The humerus remained in 60° of abduction in the coronal plane and was locked in 90° of external rotation for translation testing. The specimen was preconditioned with an alternating 10-N translational load, applied 10 times in all directions. Translational