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BASIC SCIENCE

# A biomechanical cadaveric study comparing superior capsule reconstruction using fascia lata allograft with human dermal allograft for irreparable rotator cuff tear

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**Background:** Biomechanical and clinical success of the superior capsule reconstruction (SCR) using fascia lata (FL) grafts has been reported. In the United States, human dermal (HD) allograft has been used successfully for SCRs; however, the biomechanical characteristics have not been reported.
**Methods:** Eight cadaveric shoulders were tested in 5 conditions: (1) intact; (2) irreparable supraspinatus tear; (3) SCR using FL allograft with anterior and posterior suturing; (4) SCR using HD allograft with anterior and posterior suturing; and (5) SCR using HD allograft with posterior suturing. Rotational range of motion, superior translation, glenohumeral joint force, and subacromial contact were measured at 0°, 30°, and 60° of glenohumeral abduction in the scapular plane. Graft dimensions before and after testing were also recorded. Biomechanical parameters were compared using a repeated-measures analysis of variance with Tukey post hoc test, and graft dimensions were compared using a Student *t*-test ($P < .05$).
**Results:** Irreparable supraspinatus tear significantly increased superior translation, superior glenohumeral joint force, and subacromial contact pressure, which were completely restored with the SCR FL allografts. Both SCR HD allograft repairs partially restored superior translation and completely restored subacromial contact and superior glenohumeral joint force. The HD allografts significantly elongated by 15% during testing, whereas the FL allograft lengths were unchanged.

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**Conclusions:** Single-layered HD SCR allografts partially restored superior glenohumeral stability, whereas FL allograft SCR completely restored the superior glenohumeral stability. This may be due to the greater flexibility of the HD allograft, and the SCR procedure used was developed on the basis of FL grafts.
**Level of evidence:** Basic Science Study; Biomechanics


**Keywords:** Superior capsule reconstruction; fascia lata; human dermal; allograft; biomechanics; subacromial contact pressure; superior translation; cadaver study

The most common signs of irreparable rotator cuff tear include pain from subacromial impingement, muscle weakness, and limitation of arm elevation. These signs result mainly from a loss of the superior stability of the glenohumeral joint due to the rotator cuff tear causing dysfunction of the rotator cuff muscles. This loss of the superior stability is mainly due to the defect of the superior capsule[1,7] and dysfunction of both the supraspinatus (SS) and infraspinatus muscle-tendon units. The massive irreparable rotator cuff tears are more common in the older population; the treatment becomes more challenging in a younger population. For the treatment of irreparable rotator cuff tears, if conservative measures and rehabilitation regimens fail, only limited surgical options, including tendon transfer, partial repair, and tuberoplasty, are available, but they commonly lead to reverse total shoulder arthroplasty, which is considered an end-stage or salvage procedure. To address this problem, superior capsule reconstruction (SCR) was recently developed using fascia lata (FL) autografts to restore superior stability and shoulder function. In this operation, a graft—conventionally an FL autograft—is attached medially to the superior glenoid and laterally to the greater tuberosity to reconstruct the superior shoulder capsule. Previous clinical and biomechanical studies have shown that SCR using FL autograft or allograft significantly improved superior glenohumeral stability and shoulder function. Effectively, the SCR restores shoulder function by depressing the humeral head in patients with irreparable rotator cuff tears.[11]

To date, the original SCR with FL autografts has been shown to be an effective procedure for treating massive irreparable rotator cuff tears in Japan.[8] In the United States, SCR using human dermal (HD) allograft has now become popular, and the number is growing at an exponential rate with encouraging results in the short term.[2,6,12,13] However, whereas HD allograft has previously been used to augment rotator cuff repairs or as an interposition graft for rotator cuff defects,[5,15,16] the biomechanical characteristics of SCR using HD allografts have not yet been reported. Furthermore, the demand on the SCR is greater than that of the original superior capsule as the shoulder will have to function without the cuff muscles. Therefore, the objective of this study was to compare the effects of SCR using an FL allograft and SCR using a single-layered HD allograft on shoulder biomechanics in an irreparable SS tear model. The use of HD allograft for SCR avoids donor site morbidity associated with harvesting of the FL autografts and provides technical advantages because of the uniformity of the graft. Therefore, the hypothesis of this study was that both the SCR with FL allograft and the SCR with HD allograft will restore superior stability and humeral rotational range of motion (ROM) in a human cadaver irreparable rotator cuff tear model.

## Materials and methods

### Specimen preparation and shoulder biomechanical testing setup

Eight fresh frozen cadaveric shoulders (mean age, 62 ± 5 years [range, 55-69 years]) were tested in a custom, validated shoulder testing system (Fig. 1); 5 left shoulders and 3 right shoulders were tested. There were 2 male and 6 female donors. All specimens were thawed overnight before dissection and testing and had no evidence of rotator cuff tears or other gross disease. All skin, soft tissues, and muscles were removed from the specimens except for the coracoacromial ligament, shoulder capsule, and tendinous insertions of the rotator cuff, deltoid, pectoralis major, and latissimus dorsi. The humeral shaft was transected 2 cm distal to the deltoid tuberosity. Before transection of the humeral shaft, a K-wire oriented parallel to the epicondylar axis was inserted in the proximal shaft of the humerus to assist in defining humeral rotation during testing. No. 2 FiberWire (Arthrex, Naples, FL, USA) sutures were placed in Krackow fashion through subdivisions of each preserved muscle-tendon insertion to allow muscle loading during testing (SS, 2; subscapularis, 2; infraspinatus, 1; teres minor, 1; deltoid, 3; pectoralis major, 2; latissimus dorsi, 2).

The scapula was rigidly fixed and positioned at 20° anterior tilt and 0° abduction and rotation. An intramedullary rod was rigidly fixed to the humerus and secured to the testing system, which permitted precise positioning control of all 6 degrees of freedom motion at the glenohumeral joint. The intramedullary rod was also connected to a hollow shaft potentiometer angle sensor (Novotechnik U.S. Inc., Southborough, MA) for measurement of humeral axial rotation (precision of 0.05°). With the humerus positioned in the scapular plane and 0° of glenohumeral abduction, 30° external rotation was defined as the position of the humerus when the previously placed K-wire in the proximal shaft of the humerus was oriented parallel to the scapular plane. Once humeral rotation was defined, the K-wire was removed. Two screws, 1 in the lateral aspect of the middle acromion and 1 in the proximal humerus posterior to the bicipital groove, were placed to track the position of the humerus relative to the fixed scapula (Fig. 2).

Muscles were loaded using a braided low-stretch Dacron fishing line (Izorline, Paramount, CA, USA) to the No. 2 FiberWire sutures in each tendon. The lines were fed through customized muscle plates