Repairing the Capsule to the Transferred Coracoid Preserves External Rotation in the Modified Latarjet Procedure

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Background: It is not clear whether the anterior capsule should be repaired to the coracoid process or to the native glenoid during the modified Latarjet procedure. We investigated joint stability and range of motion of the shoulder after the modified Latarjet procedure with both of these methods of capsular repair.

Methods: Eighteen fresh-frozen cadaveric shoulders were used. After a Bankart lesion and 6-mm glenoid defect were created, the coracoid process was transferred to the glenoid and fixed with screws. The anterior capsule was repaired either to the coracoid process (coracoid group) or to the native glenoid (glenoid group). The ranges of internal and external axial rotation were measured with the arm at 0° and 60° of glenohumeral abduction. The range of motion was measured with a constant torque of 200 N-mm. Joint stability was measured using a custom stability testing device. The stability ratio in the anterior-posterior direction was measured with the arm at maximal external rotation and neutral rotation.

Results: The range of external rotation was greater at both 0° and 60° of abduction in the coracoid group compared with the glenoid group (p < 0.05). The range of internal rotation was not significantly different between groups. The end-range stability ratio was not significantly different between groups, but the mid-range stability ratio was significantly greater in the glenoid group.

Conclusions: Because the difference in the mid-range stability may not be clinically relevant, we recommend repairing the capsule to the coracoid, as that preserves the range of motion in external rotation.

Clinical Relevance: Repairing the capsule to the transferred coracoid during the modified Latarjet procedure appears to be beneficial to avoid the limited range of motion in external rotation, but the direct contact of the humeral head and the transferred coracoid might confer a risk of osteoarthritis. Long-term consequences in the clinical setting need to be clarified.

The surgical procedures used to treat anterior instability of the glenohumeral joint can be classified as either anatomic or nonanatomic repairs. Although the Bankart repair, the preferred anatomic repair, is effective, patients with a large glenoid defect are at increased risk for failure and recurrent instability. The Latarjet procedure was first reported by Michel Latarjet. Later, Patte and Bernageau described repairing the anterior capsule to the remnant stump of coracoacromial ligament attached to the coracoid process. Young et al. further recommended the subscapularis muscle-splitting approach over the tendon-cutting approach. This method, known as the Walch technique, is now widely used and is considered the standard modified Latarjet procedure.

In this article, we refer to the Walch technique as the Latarjet procedure. The Latarjet procedure, with coracoid transfer,
is advocated for the treatment of shoulders with anterior glenohumeral instability and associated large glenoid defects. The success of the Latarjet procedure is the result of both the restoration of the glenoid bone anatomy and the dynamic sling effect of the subscapularis muscle and transferred conjoined tendon.

The position of the coracoid transfer is controversial because some patients continue to have excessive anteroposterior translation after the Latarjet procedure, despite bone-grafting. Therefore, capsular retensioning and positioning could have an important role. Some authors have reported that the anterior capsule should be repaired to the glenoid rim, resulting in an extra-articular bone graft. Alternatively, other authors have presented data showing that the anterior capsule is best repaired to grafted bone, creating an intra-articular graft. To our knowledge, an explicit comparison of these techniques has not been reported in the literature to date.

Multiple biomechanical studies of the Latarjet procedure have been performed. Most studies investigated the position and orientation of the bone graft and the sling effect. However, no biomechanical studies appear to have investigated the effect of the location of capsular repair on motion and stability after the Latarjet procedure. The purpose of this study, therefore, was to determine the effect of the capsular repair position on joint stability and range of motion using cadaveric shoulders. We hypothesized that repairing the capsule to the native glenoid rim would cause range-of-motion loss in the Latarjet procedure compared with repair to the transferred coracoid process.

Materials and Methods

This study was approved by the Mayo Clinic Biospecimens Committee.

Specimen Preparation

Eighteen fresh-frozen cadaveric shoulders were obtained from 9 men and 9 women; the mean age at the time of death was 71 years (range, 50 to 89 years). The shoulders were screened for rotator cuff tears and for radiographic evidence of moderate to severe glenohumeral osteoarthritis. The subcutaneous soft tissues and deltoid were dissected away to leave the intact rotator cuff, conjoined tendon, and joint capsule. A Bankart lesion was created by elevating the labrum subperiosteally from the glenoid from the 2:00 to the 8:00 o'clock position, as previously reported.

For the purpose of this study, the labrum was subsequently repaired to the glenoid rim with 2 AO 4.5-mm malleolar screws. The anterior capsule was cut in neutral rotation, a 1.5-cm vertical capsulotomy between the superior two-thirds and the inferior one-third of the muscle. The subscapularis muscle and tendon were divided horizontally at the junction of the subscapularis and teres major muscles. The bone block was positioned flush with that margin. It was transferred to the glenoid neck and was fixed to the glenoid with 2 AO 4.5-mm malleolar screws. The coracoid process was fixed with the arm in internal rotation. The anterior capsule was repaired at the 2:30, 4:00, and 5:00 o'clock positions to either the coracoid process (coracoid group) or the glenoid rim (glenoid group) in external rotation, using a transosseous suture technique, to make analogous repairs in both groups. Both procedures were performed for 18 shoulders. After the range of motion and joint stability were measured for 1 of the procedures, the other procedure was performed and the range of motion and joint stability were again measured. The experimental procedures were conducted in an alternating fashion; the coracoid procedure was tested first on odd-numbered specimens, and the glenoid procedure was tested first on even-numbered specimens.

Testing Apparatus

The testing device consisted of a 6-component load cell mounted on a motorized X-Y table (Fig. 2). The x, y, and z axes were defined as the anterior-posterior, superior-inferior, and medial-lateral directions, respectively. A 50-N medial compressive force was applied to the humeral head by a pneumatic cylinder. This 50-N value was determined on the basis of previously reported studies.

Measurements of Glenohumeral Stability

The stability test was performed with the arm at maximal external rotation (end-range position) and neutral rotation (mid-range position) after the range of motion had been measured. The X-Y table was positioned such that the movement of the humeral head relative to the glenoid was in the anterior-posterior direction. The humeral head was translated in the anterior direction for 10 mm at a rate of 2.0 mm/sec. The force analysis was based on a normalized displacement that was proportional to the glenoid length (in the superior-inferior dimension). The 10-mm displacement distance was used for the longest glenoid (long axis, 37 mm); the displacement distances for all other...
glenoids were scaled down proportionately. Only the translational force occurring at a normalized displacement (and standard deviation) of 9.1 ± 0.7 mm (range, 7.8 to 10 mm) was used. This translational force was measured at the maximal translation. In addition, loads of 20 and 5 N were applied to the subscapularis and conjoined tendon, respectively, with pulleys and weights to simulate the sling effect. Finally, the stability ratio (anterior translational force: medial compressive force) was calculated; the latter force was defined as the 50-N compressive force between the humeral head and the glenoid. Of the 18 cadaveric shoulders, 9 were first used for the stability testing at the mid-range position only, and the other 9 shoulders were then used for the stability testing.

Fig. 2
The digital torque wrench and custom mechanical testing device consisted of a load cell with 6 degrees of freedom mounted on a motorized X-Y table. First, the range of motion was measured by using a digital torque wrench. Second, after the digital torque wrench was removed, joint stability of the mounted cadaveric shoulder was investigated by using a custom mechanical testing device. (Used with permission of the Mayo Foundation for Medical Education and Research.)

Fig. 3
External rotation range of motion (left) and internal rotation range of motion (right). The external rotation range of motion was greater at 0° and 60° of abduction in the coracoid group compared with the glenoid group. *Significant (p < 0.05). The error bars indicate the standard deviation.
Discussion
Postoperative restriction of external rotation has long been criticized as a limitation of the Latarjet procedure, and anterior tightening procedures such as the Putti-Platt or Magnuson-Stack procedure result in a loss of external rotation and capsulorrhaphy arthropathy. MacDonald et al. reported that 1 cm of anterior tightening results in a 20° decrease in external rotation. Repairing the capsule to the transferred coracoid process might address the limited range of external rotation observed in some patients after the Latarjet procedure.

Although we observed no significant difference in the end-range stability between groups, mid-range stability was significantly greater in the glenoid group. Yamamoto et al. reported that 1 cm of anterior tightening results in a 20° decrease in external rotation. Repairing the capsule to the glenoid rim might have provided a more-anterior barrier effect and thus might have increased the stability ratio in the glenoid group. The present study showed that even in the mid-range of motion, where a glenoid osseous defect is known to cause instability, the capsule has a role if it is reattached to the native glenoid rim. This may be extrapolated to capsular repair without any bone.

Results
Range of Motion
The mean external rotation range of motion in the coracoid group and the glenoid group was 43.9° ± 13.0° and 30.3° ± 10.1° at 0° of abduction and 52.3° ± 15.7° and 37.0° ± 15.1° at 60° of abduction, respectively. The external rotation range of motion was significantly greater in the coracoid group than in the glenoid group at both levels of abduction (p < 0.05). The mean internal rotation range of motion in the coracoid and glenoid groups was 11.1° ± 10.4° and 10.8° ± 10.2° at 0° of abduction and 5.1° ± 16.3° and 5.1° ± 14.8° at 60° of abduction, respectively. The internal rotation range of motion was not significantly different between the groups (Fig. 3).

Stability Test
The mean stability ratio at the end range of external rotation was 1.78 ± 0.41 in the coracoid group and 1.78 ± 0.53 in the glenoid group; the difference was not significant. The mean stability ratio at the mid-range position was 0.47 ± 0.18 in the coracoid group, which was significantly less than the value of 0.76 ± 0.24 in the glenoid group (p < 0.05) (Fig. 4).

Postoperative restriction of external rotation has long been criticized as a limitation of the Latarjet procedure. Our results suggest that, compared with capsular repair to the glenoid (glenoid group), capsular repair to the coracoid (coracoid group) better preserves the range of motion without compromising joint stability at the end-range position. The anterior capsule was elongated by the thickness of the coracoid process in the coracoid group, which appeared to help preserve the external rotation (Fig. 5). In contrast, capsular repair to the glenoid tightens the anterior soft tissues and may reduce the external rotation.

Anterior capsular shortening is known to be associated with a limited range of motion, and anterior tightening procedures such as the Putti-Platt or Magnuson-Stack procedure result in a loss of external rotation and capsulorrhaphy arthropathy. MacDonald et al. reported that 1 cm of anterior tightening results in a 20° decrease in external rotation. Repairing the capsule to the transferred coracoid process might address the limited range of external rotation observed in some patients after the Latarjet procedure.

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graff in shoulders with a glenoid osseous defect, as seen with Bankart repairs in shoulders with subcritical glenoid bone defects.

The question is whether the decreased mid-range stability observed in the coracoid group affects the clinical outcome. Satisfactory stability has been reported for patients with repair of the capsule to the coracoid process. Considering those clinical reports, the decreased mid-range stability of the coracoid group observed in the present cadaveric study does not appear to be related to clinical instability. This is supported by the understanding that clinical mid-range stability depends on muscular activity (including the rotator cuff), whereas end-range stability depends on capsuloligamentous structures.

Clinically, Bouju et al. reported a low osteoarthritis rate (8.5%) at 13 years of follow-up after capsular repair to the coracoid and reported arthritis developing or progressing in 23.5% of cases 20 years after the Latarjet procedure. However, in most cases, the arthritis was mild. The relationship between the osteoarthrosis and the method of capsular repair is not clear; further clinical study is warranted.

The present study has several limitations. First, we lacked cadaver-specific information (e.g., medical history). We cannot conclusively declare that the cadaveric shoulders were completely normal, and the donors were older than the typical patient with such shoulder instability. However, the shoulders did have normal macroscopic and radiographic characteristics, although the tissue might not have had “young” biomechanical properties. Second, we repaired the capsule directly to the grafted bone in the coracoid group, whereas clinically, the capsule is repaired to the coracoclavicular ligament. We used suture anchors to repair the capsule indirectly to the bone in both groups. The range of motion and stability may not be the same as in the typical clinical conditions. Third, although this study investigated capsular repairs to the coracoid process or to the native glenoid, some authors have suggested that the capsule is not important and should be removed, in which case the findings of this study would not be relevant. Fourth, Bankart lesions and bone defects were created experimentally using cadaveric shoulders. Although the anterior capsule was clinically elongated after dislocation of the shoulder joint, the cadavers had intact capsules. Fifth, because the present study was performed only at time zero, it has not been clinically clarified whether restriction of range of motion after the Latarjet procedure is due to capsular shortening or postoperative subscapularis scarring.

In conclusion, repairing the capsule to the transferred coracoid graft appears beneficial in that it avoids limiting external rotation after the Latarjet procedure, whereas repairing the capsule to the native glenoid appears to provide better mid-range stability. Because the difference in the mid-range stability may not be clinically relevant, we recommend repairing the capsule to the coracoid, as that better preserves external rotation range of motion.

References


