RESULTS:

SGHL/MGHL closure significantly reduced the anterior translation with respect to glenohumeral motion and stability.

METHODS:

We used 14 fresh-frozen cadaveric shoulders from donors who were 25 to 88 years old (mean, 64 years old) at the time of death. A 22-N force was applied to the humeral head against the glenoid fossa with pulleys and weights. The specimen was then attached to a custom-designed shoulder-positioning device.

Preparation of the RI Capsule

The RI capsule was horizontally sectioned with use of a sharp blade approximately 2 cm in length just below the coracohumeral ligament. The imbrication of the RI capsule was performed as follows. In the imbrication between the SGHL and the SSC (SGHL/SSC closure group), the superior limb of the first suture was passed through the superior RI capsule. The inferior suture limb was then passed through the SSC tendon at the corresponding site of the superior limb placement. In the imbrication between the SGHL and the MGHL (SGHL/MGHL closure group), the inferior suture limb was passed through the MGHL where the MGHL crosses the SSC tendon. During the imbrication procedures, the specimen was kept at 0° of abduction and 30° of external rotation in order to simulate the clinical procedures.

Preparation for Translation Measurement

A translational force was applied to the proximal humerus through nylon cables, which were passed through drill holes in the proximal humerus. The three-dimensional kinematics of the humerus relative to the scapula was monitored with an electromagnetic tracking device (3Space Tracker System, Polhemus Navigation Sciences Division, McDonnell Douglas Electronics Company, Colchester, Vermont). This system allowed for measurement of the three-dimensional position and orientation of a sensor in relation to a source.

Motion Measurements

The range of motion was measured using a goniometer, while a force applied to the distal end of the intramedullary rod in each direction was monitored using a force transducer (Digital force gauge, IMADA, McDonnell Douglas Electronics Company, Colchester, Vermont). (3Space Tracker System, Polhemus Navigation Sciences Division, McDonnell Douglas Electronics Company, Colchester, Vermont). This system allowed for measurement of the three-dimensional position and orientation of a sensor in relation to a source.

DISCUSSIONS:

There are three possible mechanisms of anterior stabilization at 0° of abduction by SGHL/SSC closure: 1) tensioning of the SGHL; 2) the barrier effect of the supraspinatus and subscapularis tendon; and 3) the sealed capsular effect. O’Connell et al. (AJSM 1990), in a cadaveric study, reported that the SGHL developed the most strain in adduction and external rotation. In the present study, the RI capsule was imbricated with the arm at 0° of abduction and 30° of external rotation.

Therefore, the SGHL may be taut even in the neutral position after imbrication because the SGHL is pulled down onto the subscapularis tendon (mechanism 1). RI closure between the SGHL and subscapularis also brings the anterior border of the supraspinatus tendon closer to the subscapularis tendon. This makes a barrier composed of the supraspinatus and subscapularis tendons, which is expected to prevent the anterior displacement of the humeral head (mechanism 2). Mechanism 3 is not relevant in this experimental setup because we already vented the capsule.

Since the MGHL attaches to the capsule covering the surface of the subscapularis tendon, closing the space between the SGHL and MGHL pulls the subscapularis tendon up, closer to the SGHL. Therefore, the above mentioned three mechanisms also seem to be applicable to the stabilization observed after SGHL/MGHL closure. In addition, tight MGHL, which is the primary anterior stabilizer with the arm in adduction and external rotation, may function as an anterior stabilizer in neutral rotation because it may become tight even in neutral rotation after RI closure. Kuhn et al. (AJSM 2000) demonstrated that the contributions of the SGHL and MGHL were equal to that of the IGHL with the arm in abduction external rotation in the scapular plane. Therefore, tight MGHL is likely to increase anterior stability in abduction external rotation in the scapular plane.

CONCLUSIONS:

RI closure reduces anterior/posterior translation in adduction and anterior translation at 60° of abduction in the scapular plane. However, RI closure should be carefully considered in overhead throwing athletes because it decreases the range of external rotation and horizontal abduction.