EFFECT OF PLICATION ON GLENO-HUMERAL TRANSLATION – A PRELIMINARY IN VITRO STUDY

[1,2]S Rao, [5]A Miana, [2]M Lenhoff, [2] S Backus, [7]B Vanadurongwan, [4]N Chen, [4]S Coleman, [4]F Cordasco, [4]D Altchek, [2]S Fealy, [3]C Imhauser, [6]A Karduna,[4]R Warren, [2]H Hillstrom

[1]New York University, New York, USA; [2]Leon Root Motion Analysis Lab, [3]Biomechanics Department, [4]Orthopedics Department, Hospital for Special Surgery, New York, USA; [5]Instituto Vita, Sao Paulo, Brazil; [6]University of Oregon, Eugene, USA; [7]Siriraj Hospital, Mahidol University, Bangkok, Thailand
email: smita.rao@nyu.edu

INTRODUCTION

- Clinical evidence suggests that capsular plication surgery may correct anterior instability of the shoulder.
- However, previous studies demonstrating improved glenohumeral joint stability following thermal or arthroscopic capsulorrhaphy have quantified glenohumeral stability as humeral head translation assessed using a mechanized jig [1] or simulated clinical testing [2].
- No studies have assessed the effect of suture plication on humeral head translation during functional open chain activities (flexion, abduction and external rotation). These findings are important because open chain functional activities are frequently used by individuals reporting anterior shoulder instability.

The purpose of our study was to assess the effect of plication on humeral head translation during three functional open chain activities; flexion, abduction and external rotation.

METHODS

Instrumentation: One mechanically grounded cadaver (two upper limbs). Steinmann pins were inserted into the scapula and humerus, and four reflective markers were rigidly attached to each pin. The scapula and humerus were tracked using these bone mounted rigid clusters.

Anatomical coordinate systems were defined, according to ISB recommendations, [3] for the scapula and humerus with a digitizing pointer. Coordinate systems depicted in Fig. 1.

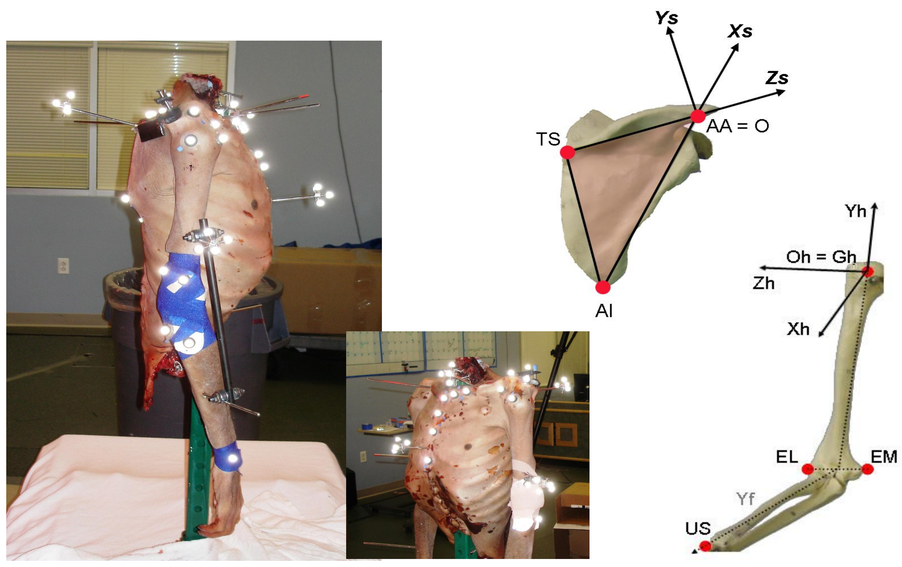


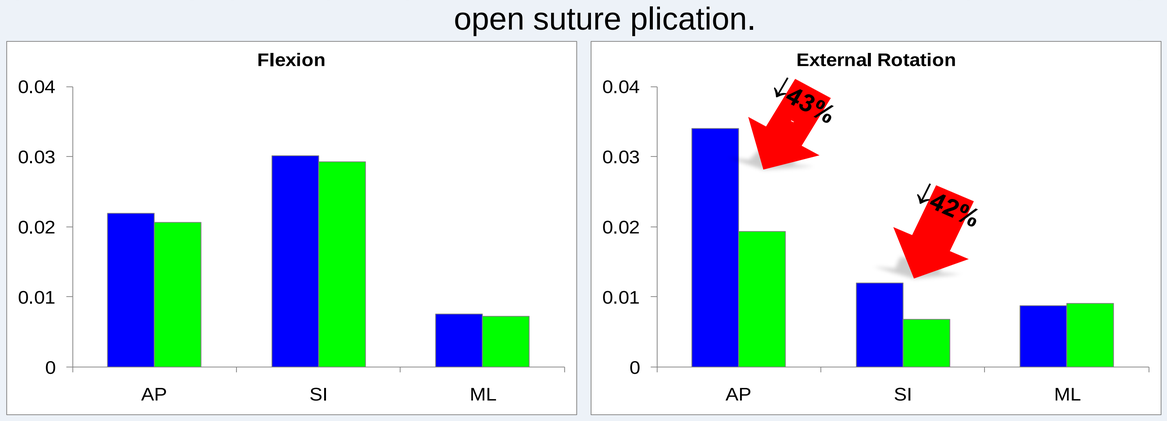
Figure 1. Scapula and humerus co-ordinate systems

1) 6 Degree of Freedom (DOF) kinematic data were collected at 100 Hz, using a 10-camera system (Motion Analysis, CA)
2) Kinematic data were collected during three tasks (glenohumeral flexion, abduction and external rotation)
3) Two conditions were assessed: before and after open suture plication by an orthopedic surgeon (NC)

Data Analysis:
Data were analyzed using Visual 3D. Gleno-humeral flexion, abduction and external rotation, and corresponding translations, were the dependent variables of interest. Euler angles were defined using a y-z'-y'' sequence of rotations, where y=SI axis, and z=ML axis, [3] and referenced to anatomical neutral.

RESULTS

Figure 2. Bar graphs depicting humeral head translation before (**blue**) and after (**green**) open suture plication.



- Modest reduction in antero-posterior (AP) and supero-inferior (SI) translation was noted following plication (n=2 shoulders) during external rotation (Top right).
- No differences in humeral head translation were found during flexion or abduction (Top left and adjacent).

CONCLUSIONS AND DISCUSSION

- We developed a novel cadaveric model with which to study the passive motion characteristics of the glenohumeral joint, before and after open suture plication. These findings may be important because they help define mechanisms by which open suture plication may affect shoulder mechanics.
- The findings of our preliminary study indicate that suture plication is accompanied by reduction in anterior-posterior translation of the humeral head during open chain external rotation. Our results demonstrating a 43% decrease in anterior-posterior translation during external rotation, following plication are consistent with previous findings demonstrating 45-60% change in humeral head translation following surgery [1, 2].
- These results are consistent with previous reports and indicate that suture plication affords improved glenohumeral stability without loss of functional range of motion. The difference in magnitude of translation may also be explained by extent of shoulder loading during activity and by differences in surgical technique.
- The current study used a bone-pin based, 6 DOF, *in vitro* model and focused on passive motion characteristics to understand the role of the passive constraints in stabilizing and controlling bone motions. Future studies will extend this approach to *in vivo* models and include the contribution of shoulder musculature to glenohumeral motion.

REFERENCES:
1. Alberta, F.G., et al., J Bone Joint Surg Am, 2006. 88(1): p. 179-87.
2. Magit, D.P., J.E. Tibone, and T.Q. Lee, Am J Sports Med, 2008. 36(7): p. 1389-96.
3. Wu, G., et al. J Biomech, 2005. 38(5): p. 981-992.

ACKNOWLEDGEMENTS:
David Adar from the Psychomotor Skill Laboratory at Hospital for Special Surgery for assistance with the cadaveric specimen.

HOSPITAL FOR SPECIAL SURGERY