Coracoclavicular Functional Distance During Shoulder Elevation Movements In Reconstructed Acromioclavicular Joints Versus Non-Operative Treatment

Jason Konrath[1], Sydney Wheaton[1], Alonso Figueroa[1], James Gregory[1], Payam Zandiyeh
[1]University of Houston Health Science Centre, Department of Orthopedic Surgery, Houston, TX
Jason.Konrath@uth.tmc.edu

Disclosures: Jason Konrath (N), Sydney Wheaton (N), Alonso Figueroa (N), James Gregory (Stryker, Arthrex), Payam Zandiyeh (N).

INTRODUCTION: Acromioclavicular joint (ACJ) injuries are particularly common among young, active individuals, especially those involved in contact sports. Injury severity is classified using the Rockwood system, with Type III injuries representing a point of ongoing debate regarding optimal treatment. Surgical reconstruction is typically recommended for individuals with significant instability or those who do not respond to conservative management.[1] Restoring normal ACJ biomechanics is essential not only for joint stability but also for preserving long-term shoulder function through proper scapular mechanics. Recent focus has shifted toward anatomically reconstructing the coracoclavicular (CC) ligaments to concomitantly address vertical and horizontal instabilities of the clavicle after ACJ disruption. Unfortunately, the ramifications of not performing surgical reconstruction on CC mechanics are unknown. The aim of the present study was to investigate the functional distance between CC ligament insertion points across multiple planes of shoulder elevation in both surgical and non-operative patients. We hypothesized that non-operative patients would exhibit significantly greater functional distances between CC ligament insertion points compared to those who underwent surgical reconstruction.

METHODS: Seventeen participants (15 men and 2 women, mean age 39 ± 10 years, mean body mass 92 ± 17kg) who had sustained an acute unilateral ACJ disruption with Rockwood classification of III-IV within 1 to 3 years, were recruited for this retrospective clinical study (IRB code: HSC-MS-20-0585). Twelve had elected to undergo an ACJ reconstruction, while five participants opted for non-operative treatment. Patient-specific 3-D bone models were generated from computerized tomography and combined with biplanar dynamic stereo x-ray (DSX) images[2], to model ACJ motion across abduction, flexion, and scaption. Locations of the conoid and trapezoid ligament insertion points were estimated using predictive calculations based on specific measurements taken from anatomical landmarks for the clavicle and coracoid process. The functional distances between these insertion points were then calculated at each time point throughout the recorded motions.

RESULTS: Figure 1 presents the functional distance between conoid and trapezoid insertion points throughout the entire movement cycle (elevation and depression phases) for abduction, flexion, and scaption. Significant differences were detected between the surgical group and non-operative group, as well as compared to uninjured shoulders. The peak distance between conoid and trapezoid insertion points is presented in Table 1.

Peak Distance (mm)		**Conoid**			**Trapezoid**		
		Non-Operative	Surgical	Uninjured	Non-Operative	Surgical	Uninjured
Elevation Phase	Abduction	34.7 ± 4.9*	23.6 ± 6.1	19.8 ± 5	30.4 ± 3.2*	21 ± 7.1	17.8 ± 5.3
	Flexion	36.3 ± 4.9*	23.7 ± 5.5	19.6 ± 4.6	32.5 ± 2.3*	22.1 ± 6.8	17.9 ± 5.3
	Scaption	35 ± 4.6*	23.5 ± 6.8	20.4 ± 5.6	31.1 ± 3.2*	21.4 ± 6.9	18.6 ± 6.4
Depression Phase	Abduction	34.8 ± 4.8*	23.5 ± 5.9	20.2 ± 4.9	30.2 ± 2.8*	21.1 ± 6.6	18.1 ± 5.5
	Flexion	36.7 ± 5.3*	23.4 ± 5.5	19.7 ± 4.5	33 ± 2.9*	21.9 ± 6.9	17.7 ± 5.3
	Scaption	35 ± 4.3*	23.6 ± 6.6	20 ± 5.3	31.1 ± 2.9*	21.2 ± 6.5	18.2 ± 6.4

*Table 1: Peak distance (mm) between ligament insertion points for the conoid and trapezoid. * denotes statistical significance.*

During both the elevation and depression phases of movements. The non-operative group demonstrated a greater peak distance between conoid and trapezoid insertion points across all movements when compared to the surgical group ($p<0.001$). Further, both the non-operative and surgical groups showed greater distance between conoid and trapezoid insertion points, across all movements, when compared to the uninjured contralateral shoulder ($p<0.001$).

DISCUSSION: This study used dynamic stereo X-ray (DSX) combined with patient-specific 3D bone models to investigate the functional distance between coracoclavicular (CC) ligament insertion points in surgical and non-operative groups. The non-operative group demonstrated up to 56% and 50% greater distances between the conoid and trapezoid insertion points, respectively, compared to the surgical group during abduction, flexion, and scaption. Given that both ligaments play a critical role in resisting vertical, shear, and posterior loading, these increased distances may indicate a failure to restore native joint kinematics. This mechanical deficiency could contribute to abnormal scapular motion, as the scapula and clavicle must function as a coordinated unit linked by the acromioclavicular (AC) and CC ligaments—a relationship known to be disrupted in individuals with ACJ injuries.[3] Although both surgical and non-operative groups exhibited differences relative to the uninjured contralateral limb, these deviations were substantially greater in the non-operative group. The findings of this study underscore the importance of restoring the native anatomy of the CC ligaments during humeral elevation in multiple planes. Inadequate restoration may have negative long-term consequences on shoulder health, function, and longevity.

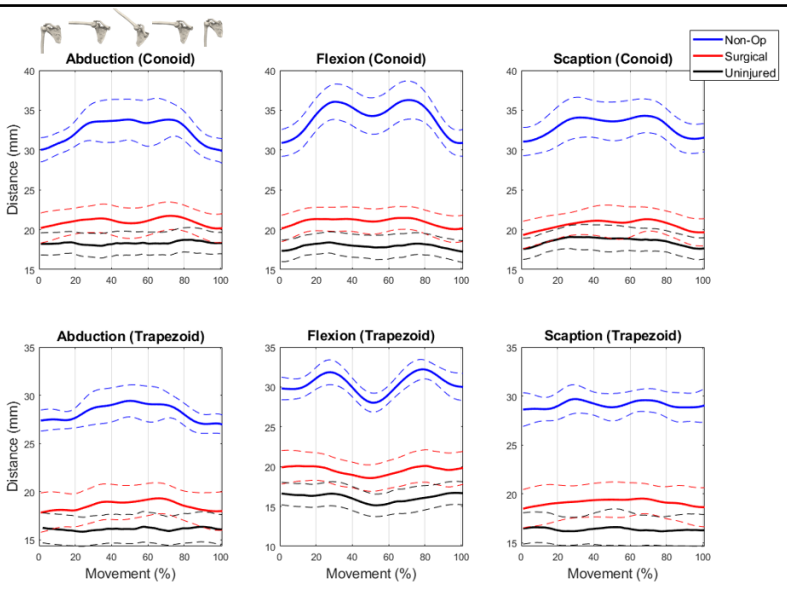

Fig 1: Length (mean ± SE) of the conoid and trapezoid ligaments throughout abduction, flexion and scaption, for the non-operative(blue), surgical (red) and uninjured limbs (black). (Note: Movement includes both elevation and depression phases)

SIGNIFICANCE/CLINICAL RELEVANCE: The CC ligaments play a critical role in maintaining shoulder stability; restoring their native biomechanics may be essential to prevent scapular dysfunction.

REFERENCES: [1] Okereke et al. (2022) *Cureus.* 14(9):e28657; [2] Zandiyeh et al. (2024) *Orthop J Sports Med.* 12(10); [3] Gumina et al. (2009) *J Arth Rel Surg.* 25(1):40-45.