

Anatomic variance of the coracoclavicular ligaments

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The coracoclavicular ligaments vary widely in morphology and anatomic descriptions. Few authors have adequately described the coracoclavicular ligaments' anatomy, and a number of discrepancies exist in the anatomy literature. This study examines the complex anatomy of the coracoclavicular ligaments and their relationships to clinically important bony landmarks. The geometric dimensions of 24 coracoclavicular ligament specimens from fresh human cadaveric shoulders were examined and quantified with 13 different measurements. Particular attention was given to any inter-specimen anatomic variance. The coracoid insertions of the conoid ligaments displayed high variance, with 33% (8/24) being confluent with the lateral fibers of the superior transverse scapular ligament. A further 15% (3/24) presented an additional lateral fascicle. The distance from the lateral trapezoid ligament to the distal clavicle averaged 15.3 mm. Three distinct and previously unreported conoid ligament variants lend themselves to an anatomic classification (types I, II, and III). A safety margin of 15 mm is suggested for distal clavicle resection in incomplete acromioclavicular joint injuries to preserve the intact coracoclavicular ligament. (J Shoulder Elbow Surg 2001;10:585-8.)

INTRODUCTION

The coracoclavicular region varies greatly in development and its described anatomy. Much of the variation described in the literature relates to the presence and form of articular facets and synovial structures within the coracoclavicular ligaments, sometimes forming well-developed diarthrodial articulations or a coracoclavicular joint. Several authors have cited the presence and incidence of coracoclavicular joints in various populations and racial groups.^{1,4,6,7,9,11} Definitions of the

joint range from cartilaginous extensions of the conoid tubercle of the clavicle to the presence of synovial capsules and articular disks intervening across the space. Lewis,⁴ in describing the presence of 3 coracoclavicular bursae, postulated that a coracoclavicular joint can be defined as a spectrum of features from a bursa to a well-developed articulation, and the form warranting description as a joint is a matter of opinion. Textbooks and anatomic studies differ widely in their representations of the course and attachments of the coracoclavicular ligaments—the conoid and trapezoid. The complex topography of the coracoid process and the irregular shapes of the conoid and trapezoid ligaments often complicate descriptions and 2-dimensional drawings. Furthermore, there are few geometric data that quantify the ligament dimensions and bony relationships of the region.

Mechanical studies have only recently examined the function of the conoid and trapezoid ligaments in human cadaveric models.^{2,3,5} Although the true function of these ligaments is still unknown, the complex as a whole provides clinically important structural support for the acromioclavicular joint. This study examines the morphology of the coracoclavicular ligaments and revisits their complex anatomy.

MATERIALS AND METHODS

Nineteen fresh-frozen and 5 embalmed shoulder specimens were dissected free of all nonligamentous soft tissue and examined macroscopically. All donors were white persons with a mean age of 70 years (range, 55-90 years) and were free of musculoskeletal disease. Anatomic examination included 13 different geometric measurements (Figure 1), mapping of the coracoid and clavicular attachment areas, and a description of the anatomic courses and relationships of the conoid and trapezoid components.

All measurements were taken with the clavicle and scapula aligned anatomically, with the tension on the coracoclavicular ligaments estimated to be as close to equal as possible. To simulate resting in vivo loading conditions, the scapula was suspended by gravity from the clavicle, ensuring that the acromioclavicular joint was approximated and uniform tension on both the conoid and trapezoid ligaments could be palpated. Specific bone-ligament insertion landmarks were defined on the coracoid and clavicle to serve as boundary markers of ligament borders. Ligament boundaries and the axes along which they were measured are described in Figure 1. All geometric measurements were recorded 3 times with Vernier calipers accurate to 0.1 mm. A fourth measurement was performed by an

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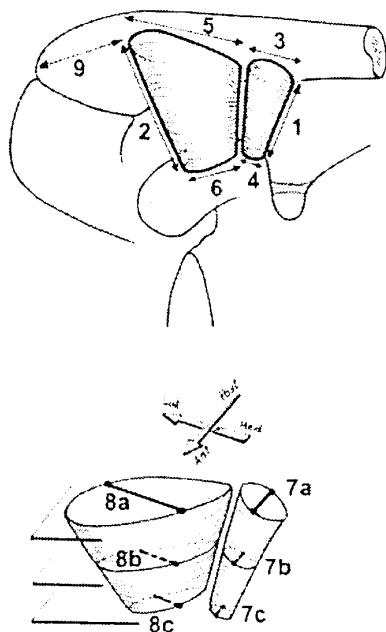


Figure 1 The 13 measured ligament dimensions. 1, Medial conoid length; 2, anterior trapezoid length; 3, conoid clavicular width; 4, conoid coracoid width; 5, trapezoid clavicular width; 6, trapezoid coracoid width; 7, conoid thickness (a, superior; b, middle; c, inferior); 8, trapezoid thickness (a, superior; b, middle; c, inferior); 9, distal clavicle.

independent recorder for precision. The 4 values were averaged. Ligament attachment areas were mapped by transecting ligaments close to their insertions, leaving only remnants of fibers. Inter-specimen variation in anatomic course and relationships of the conoid and trapezoid ligaments were also recorded.

RESULTS

A summary of the geometric parameters measured is listed in the Table. In all 24 specimens, the conoid and trapezoid ligaments originated from a broad area on the clavicle and tapered cephalocaudally to a smaller insertion area on the coracoid. The conoid ligament's clavicular insertion was approximately twice as wide (medial to lateral) and thick (anterior to posterior) as its coracoid insertion, giving rise to its inverted cone shape. The trapezoid ligament was more than 3 times thicker at its clavicular end than at its coracoid end, but its width narrowed to a lesser extent than the conoid ligament. The free edges of the conoid and trapezoid ligaments were nearly identical in length (superior to inferior), despite the much shorter appearance of the conoid ligament when it is viewed anteriorly. Distal clavicle measurements (ie, the inferior portion of distal clavicle not covered by the trapezoid ligament) averaged 15.3 mm. Some specimens were as close as 11 mm.

Table Mean, range, and SD of averaged geometric measurements

Dimension (mm)	Mean	Range	SD
1. Medial conoid length	19.4	13.5-27.3	4.8
2. Anterior trapezoid length	19.3	15.0-23.0	2.6
3. Conoid clavicular width	20.6	15.5-25.0	3.6
4. Conoid coracoid width	10.6	7.0-12.5	2.0
5. Trapezoid clavicular width	21.7	16.5-29.5	4.0
6. Trapezoid coracoid width	14.0	10.5-18.0	2.8
7. Conoid thickness			
a. Superior	8.6	5.7-10.5	1.6
b. Middle	5.9	3.8-7.1	1.1
c. Inferior	4.4	3.2-5.2	0.7
8. Trapezoid thickness			
a. Superior	16.0	12.2-20.5	3.1
b. Middle	5.5	3.1-8.9	1.9
c. Inferior	4.8	3.8-5.6	0.6
9. Distal clavicle	15.3	11.0-22.8	3.8

Medial conoid length, Distance between coracoid and clavicular insertions along medial border; *Anterior trapezoid length*, distance between coracoid and clavicular insertions along anterior border; *Conoid clavicular width*, greatest distance between medial and lateral clavicular insertion borders; *Conoid coracoid width*, greatest distance between medial and lateral coracoid insertion borders; *Trapezoid clavicular width*, distance between anterior and posterior clavicular insertion points; *Trapezoid conoid width*, distance between anterior and posterior conoid insertion points; *Conoid thickness: Superior*, distance between anterior and posterior aspect at clavicle insertion; *Middle*, distance between anterior and posterior aspect at midpoint between clavicle and coracoid; *Inferior*, distance between anterior and posterior aspect at coracoid insertion; *Trapezoid thickness: Superior*, distance between medial and lateral aspect at clavicle insertion; *Middle*, distance between medial and lateral aspect at midpoint between clavicle and coracoid; *Inferior*, distance between medial and lateral aspect at coracoid insertion; *Distal clavicle*, distance from lateral-most clavicular attachment of trapezoid ligament to distal border of superior clavicle.

The trapezoid ligament's clavicular attachment area was typically oval-shaped, encircling the trapezoid ridge and an extensive area medial to it. In some specimens the shape of the attachment area was narrower and more oblong than oval. Regardless of the shape, the trapezoid ridge served as the lateral limit of the trapezoid ligament's attachment area. The trapezoid ligament's coracoid insertion covered the majority of the posterior half of the coracoid dorsum, with the exception of the posterior-most limit near the angle of the coracoid (the point at which the horizontal plateau drops off steeply).

The clavicular attachment area of the conoid ligament was limited by the conoid tubercle posteriorly and extended into an oval-shaped area anterior to it. This area lay directly adjacent to the attachment of the trapezoid ligament. The attachments of the 2 ligaments were separated, however, by a brief interval filled by



Figure 2 In addition to the normal ligament insertion at the posterior vertical component of the coracoid, the conoid and superior transverse scapular ligaments formed one continuous structure from the medial suprascapular notch, via the coracoid to the clavicle.

the main coracoclavicular bursa, which extended superiorly from the coracoid. The coracoid insertion of the conoid ligament differed considerably between specimens. In all cases the conoid inserted at the posterior-most area of the coracoid dorsum, limited anteriorly by the insertion of the trapezoid ligament. Posteriorly, the attachment extended just beyond the angle of the coracoid to the top of the vertical component of the coracoid, or the posterior coracoid precipice. This point was often marked by a small bony elevation previously referred to by Testut¹⁰ as the *apophyse du conoide*, or conoid apophysis.

Interestingly, in 6 specimens (33%) the conoid ligament was attached at 2 points caudally. In this group the conoid ligament extended halfway down the posterior coracoid precipice, at the same time blending with the fibers of the superior transverse scapular ligament. In addition to the normal ligament insertion at the posterior vertical component of the coracoid, the conoid and superior transverse scapular ligaments formed one continuous structure from the medial suprascapular notch, via the coracoid to the clavicle (Figure 2).

In 3 specimens (15%) the above configuration was also noted with the addition of a very distinct additional fascicle that originated from the base of the coracoid where the fibers of the conoid and superior transverse scapular ligaments met. This accessory fascicle coursed superolaterally on the posterior margins of the conoid and trapezoid ligaments to insert on the clavicle near the lateral border of the trapezoid ligament's attachment.

DISCUSSION

This anatomic study presents the basic macroscopic features and geometry of the coracoclavicular ligament in 24 shoulder specimens. The observations in this

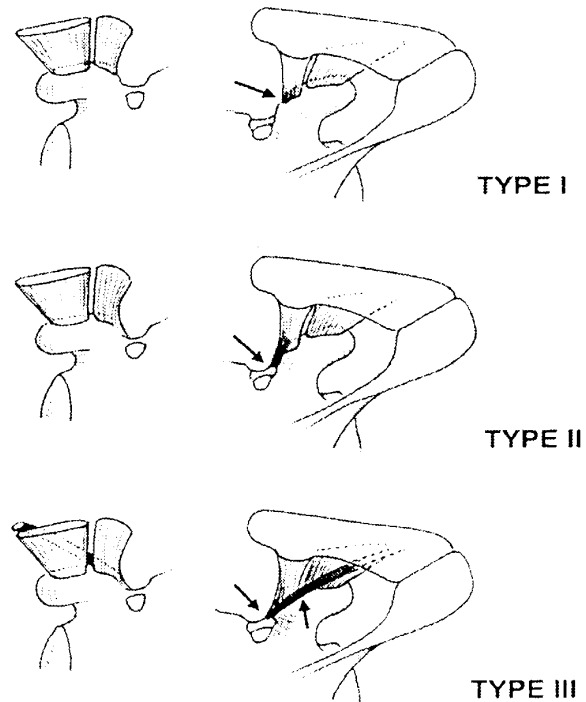


Figure 3 Proposed classification of the coracoclavicular ligament based on its variant scapular attachments.

series also revealed previously unreported anatomic variants of the coracoclavicular ligaments that lend themselves to a classification system based on their scapular attachments (Figure 3).

Our findings suggest 3 distinct anatomic variants of the conoid ligament based on their inferior attachment sites. In type 1, the common type, the conoid ligament originates from an area encompassing the posterior aspect of the coracoid dorsum and an area just beyond the posterior coracoid precipice. In type 2, the 2-point attachment, the confluence of the conoid ligament and superior transverse scapular ligament form one continuous structure from the medial scapular notch, via the coracoid to the clavicle. In this type, inferior attachment areas of the complex include the dorsum and posterior coracoid precipice and the superior border of the scapula, via the superior transverse scapular ligament. Type 3, the accessory fascicle, is variant of type 2 with an accessory conoid lateral fascicle arising inferomedially from the lateral border of the scapular notch at the junction of the conoid and superior transverse scapular ligament, coursing superolaterally, and inserting at the lateral border of the trapezoid's clavicular insertion area.

The accessory posterior conoid fascicle described in the type 3 classification in this study was illustrated diagrammatically by Testut¹⁰ and mentioned in the text by Lewis.⁴ Neither indicated its prevalence or whether this configuration is considered anomalous.

We noted its presence in approximately 15% of specimens examined.

To our knowledge, the type 2 variant observed in this study, with the convergence of fibers from the conoid and superior transverse scapular ligaments, is not documented in text or illustration elsewhere. This is surprising considering its prevalence in our series (approximately 33%).

The clinical implications of these variations give rise to speculation. The strength and load-sharing capabilities of the coracoclavicular ligament, and hence the stability of the acromioclavicular joint, may be affected by a differing course and configuration of ligament attachments. Another possibility is that the morphologic arrangement may predispose a patient to suprascapular nerve entrapment, although the variations noted did not appear to narrow the suprascapular notch, which has been suggested as a cause of nerve compression.⁸

This anatomic study may clarify certain misconceptions about the general geometry and course of the coracoclavicular ligament. It is difficult, however, to predict the frequency of the variants in the general population, given that our small sample came solely from a white population. Nevertheless, the anatomic observations and data provide detailed configurations and a new classification of the coracoclavicular ligament based on attachments previously not described.

REFERENCES

1. Cho BP, Kang HS. Articular facets of the coracoclavicular joint in Koreans. *Acta Anat (Basel)* 1998;163:56-62.
2. Fukuda K, Craig EV, An KN, Cofield RH, Chao EY. Biomechanical study of the ligamentous system of the acromioclavicular joint. *J Bone Joint Surg Am* 1986;68:434-40.
3. Harris RI, Wallace AL, Harper GD, Goldberg JA, Sonnabend DH, Walsh WR. Structural properties of the intact and reconstructed coracoclavicular ligament complex. *Am J Sports Med* 2000;28:103-8.
4. Lewis OJ. The coracoclavicular joint. *J Anat* 1959;93:296-303.
5. Motamedi AR, Blevins FT, Willis MC, McNally TP, Shahinpoor M. Biomechanics of the coracoclavicular ligament complex and augmentations used in its repair and reconstruction. *Am J Sports Med* 2000;28:380-4.
6. Nalla S, Asvat R. Incidence of the coracoclavicular joint in South African populations. *J Anat* 1995;186:645-9.
7. Ray LJ. Bilateral coraco-clavicular articulations in the Australian Aboriginal. *J Bone Joint Surg Br* 1959;41:180-4.
8. Rengachary SS, Burr D, Lucas S, Hassanein KM, Mohn MP, Matzke H. Suprascapular entrapment neuropathy: a clinical, anatomical, and comparative study. Part 2: anatomical study. *Neurosurgery* 1979;5:447-51.
9. Salter EG Jr, Nasca RJ, Shelley BS. Anatomical observations on the acromioclavicular joint and supporting ligaments. *Am J Sports Med* 1987;15:199-206.
10. Testut L. *Traite d'anatomie humaine, tome premier*. Paris: Octave Dion; 1904.
11. Wertheimer LG. Coracoclavicular joint—surgical treatment of a painful syndrome caused by an anomalous joint. *J Bone Joint Surg Am* 1948;30:570-8.