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# The costoclavicular ligament revisited: a functional and anatomical study

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**Abstract**

*Introduction*: The sternoclavicular joint is of clinical importance. However, there is scant information in the literature regarding one ligament of this area, the costoclavicular ligament (CCL). *Material and Methods*: In order to further elucidate this structure, 10 adult formalin-fixed cadavers (17 sides) underwent dissection of the CCL. Once the CCL was identified, measurements were made of its dimensions and observations made of its anatomy. Next, ranges of motion were performed of the upper extremity and the CCL observed for tension or laxity. *Results*: Of the 17 sternoclavicular regions examined 16 (94%) were found to possess a CCL. The average medial and lateral lengths, width and thickness were 1, 2, 1.2, 0.340 cm, respectively. The width of the CCL was statistically smaller in women that in men. The majority of ligaments were single structures traveling from the inferior surface of the medial clavicle just lateral and sometimes-fused (12.5%) to the lateral edge of the sternoclavicular joint. These fibers then terminated on the medial end of the first rib and first costal cartilage (75%) or exclusively onto the first costal cartilage (25%). Most ligaments were single and not composed of two parts. Arm abduction resulted in tautness of the ligament and increased as the degree of abduction increased. Internal rotation of the arm translated into medial shift of the clavicle, raising the clavicle away from the first rib creating tension on the CCL. Moderate degrees of external rotation were required before the CCL became taut and even began to pull the first rib laterally. Small amounts of protraction and retraction of the scapula both put the CCL under tension. *Conclusions*: The CCL is a constant structure found just lateral to the sternoclavicular joint. This ligament was a single band in the majority of our specimens and limited most ranges of motion of the proximal upper limb thus stabilizing the sternoclavicular region.

***Keywords***: anatomy, sternoclavicular joint, stability, subclavius.

## Introduction

The sternoclavicular joint is responsible for the articulation and connection between the upper limb and the axial skeleton [1]. Dislocation of the sterno-clavicular joint can be associated with life-threatening complications; therefore, a thorough knowledge of the ligaments contributing to sternoclavicular joint stability is essential for the clinician dealing with this anatomical area [2].

The costoclavicular ligament (CCL) (rhomboid ligament) is one of the ligaments of this region that is said to assist in limiting rotation and stabilization [3–5]. This ligament is found just lateral to the sternoclavicular joint and joins the first rib and the medial end of the clavicle where it attaches to its costal tuberosity on its undersurface [4]. Its close association with the subclavius muscle and tendon (Figure 1) has been remarked upon and its functional significance has had conflicting reports [5]. Unfortunately, the role of the CCL has been overlooked because of the low incidence of injury in the general population. To our knowledge, only one study from over almost half of a century ago has been devoted to this structure. Clinically, the CCL has been implicated in injuries seen in certain operative professions such as painters, construction workers, and kayakers and its attachment onto the clavicle has been used as a bony stress marker for anthropological studies [1, 6, 7].

Studies investigating the placement of venous catheters [8], pacemakers [9, 10], landmarks for clavicular resection [2], and prevention of clavicular dislocation injuries [1] have demonstrated the clinical relevance of the CCL. In addition, as the subclavian vein (Figure 2) travels just posterior to the CCL, this ligament has been implicated in the subclavian vein occlusion characterrized in Paget–Schroetter syndrome [12, 13].

With these reports, the purpose of the present study was to further elucidate the morphology and function of the CCL.

## Material and Methods

Following institutional review board approval, 10 adult formalin fixed cadavers (six male and four female) underwent dissection of the CCL. The ages of the specimens ranged from 55 to 90-year-old (mean 72-years). In the supine position, the overlying pectoralis major muscle was removed and the medial interval between the clavicle and first rib exposed. Once the CCL was identified, measurements (length, width, thickness) were made of its dimensions and observations made of its morphology. Next, ranges of motion were performed of the upper extremity and the CCL observed for tension or laxity. Finally, the sternoclavicular joint and midpoint of the clavicle were resected so that the medial one-half of the clavicle could be turned down anteriorly to view the posterior aspect of the CCL. Relationships between the CCL and subclavius tendon were documented. All measurements were made by all authors with calipers, rulers and gonio-meters. Measurements were statistically analyzed (Statistica), and a "two-tail" *p*-value calculated for each with significance set at $p<0.05$. No specimen was noted to have gross pathology in the region of the CCL or evidence of past surgical intervention to the medial clavicle or sternoclavicular joint. Causes of death were not due to trauma and ranged from myocardial infarction to brain tumor. All specimens were derived from a local Caucasian group. The overall nutrition of the cadavers was good.

## Results

Of the 10 cadavers examined, seven had both clavicles intact. The remaining three cadavers had only one clavicle intact due to fracture or dislocation from previous dissections. Of the 17 sternoclavicular joints examined 16 (94%) were found to possess a CCL. The fiber direction of these structures traveled in a superolateral to inferomedial manner in a more or less oblique nature.

The average medial and lateral lengths, width and thickness were 1, 2, 1.2, and 0.340 cm, respectively. The ranges for these dimensions were 0.6–1.5 cm, 1–2.9 cm, 0.3–1.9 cm, and 0.2–0.7 cm, respectively. Table 1 lists the details of the measurements made of the CCL.

**Table 1 –** ***Measurements [cm] and statistical results (P) of the CCL for left and right sides and genders. Standard deviations represented as σ***

| | Medial Length | Lateral Length | Width | Thickness |
|---|---|---|---|---|
| *Right Mean* | 1.015 | 1.85 | 1.15 | 0.362 |
| *Right σ* | 0.299 | 0.602 | 0.509 | 0.168 |
| *Left Mean* | 1.00 | 2.21 | 1.41 | 0.314 |
| *Left σ* | 0.258 | 0.55 | 0.302 | 0.121 |
| *P* | 0.933 | 0.247 | 0.253 | 0.542 |

| | Lateral Length | Medial Length | Width | Thickness |
|---|---|---|---|---|
| *Male Mean* | 2.14 | 1.04 | 1.44 | 0.39 |
| *Male σ* | 0.306 | 0.521 | 0.263 | 0.152 |
| *Female Mean* | 1.78 | 0.94 | 0.94 | 0.24 |
| *Female σ* | 1.297 | 0.367 | 0.832 | 0.168 |
| *P* | 0.282 | 0.521 | 0.028 | 0.056 |

When the dimensions of the CCL were compared between male and female specimens, both the lateral and medial lengths and the thickness of each ligament showed no statistically significant size variance between male and female. However, the width of the ligament was statistically smaller in women that in men ($p<0.05$). Of the 16 CCLs examined, eight were from the right side and eight came from the left. The majority of ligaments were single structures traveling from the inferior surface of the medial clavicle just lateral and sometimes fused (12.5%) to the lateral edge of the sternoclavicular joint. These fibers then terminated on the medial end of the first rib and first costal cartilage (75%) or exclusively onto the first costal cartilage (25%). The subclavian veins were in intimate contact to the posterior surface of all CCL (Figure 2).

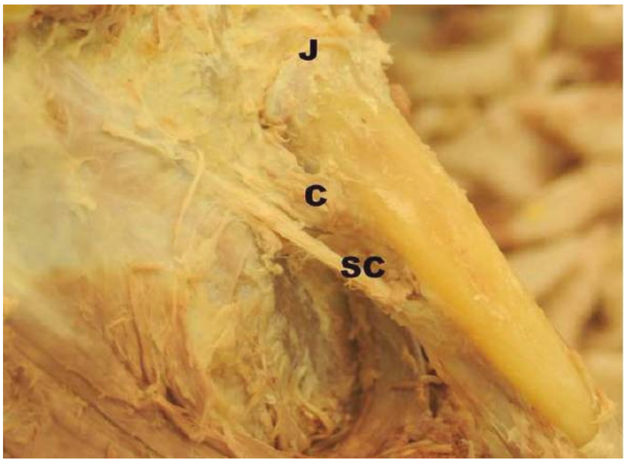


**Figure 1 –** ***Cadaveric image demonstrating the left CCL (C). Also note the subclavius tendon (SC) inserting just anterior to this ligament.***

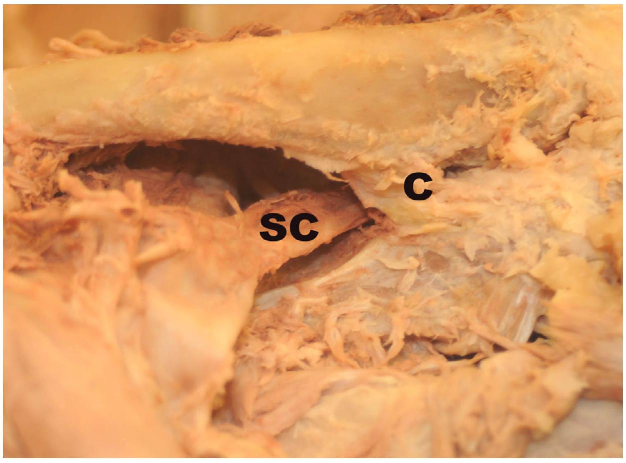


**Figure 2 –** ***Right side from a cadaveric specimen noting the CCL (C), sternoclavicular joint (J), and subclavian vein (SC) in close proximity to the CCL.***

The majority of subclavius tendons inserted intimately anterior to the CCL with the exception of one specimen where the tendon of this muscle split the CCL into two parts. No bursa was associated with any CCL as has been previously described [5]. One specimen was identified in which a central venous line had been inserted before death and had pierced the CCL (Figure 3). Ossification was not noted in any CCL.

When the upper limb was abducted the tautness of the ligament increased as the degree of abduction increased. All of the ligaments reached a point of maximal tautness where the ligament began to pull the first rib with the clavicle. This point occurred at $90^0$ of abduction for five out of the ten cadavers, with symmetry more or less displayed between the two sides. For two of the remaining cadavers the point of maximal tautness did not occur at $90^0$ of abduction but rather with an additional $5–10^0$ of scapular rotation. For another cadaver, this point occurred at $75^0$ of abduction of the upper limb. One cadaver showed asymmetry with the right side reaching maximal tautness at $90^0$ of abduction and the left side not reaching this point until greater than $90^0$, that is will an additional small amount of scapular rotation. Internal rotation of the arm translated into medial shift of the clavicle, raising the clavicle away from the first rib creating tension in the ligament (Figure 4).

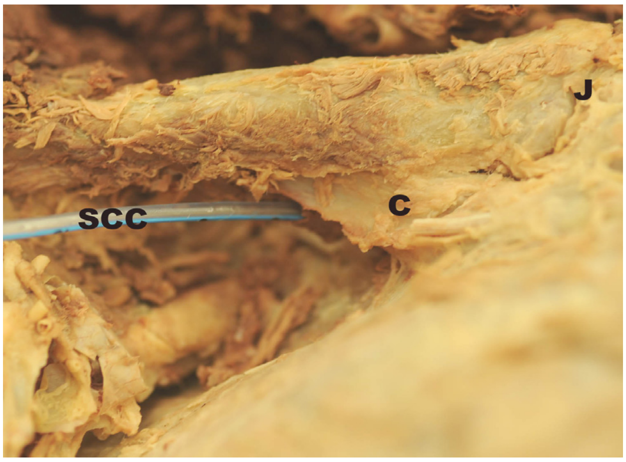


**Figure 3 –** ***Right-sided cadaveric specimen noting a pre-mortem central venous line catheter that traversed the CCL (C) after being inserted into the subclavian vein (SCC. For orientation, not the right sterno-clavicular joint (J).***

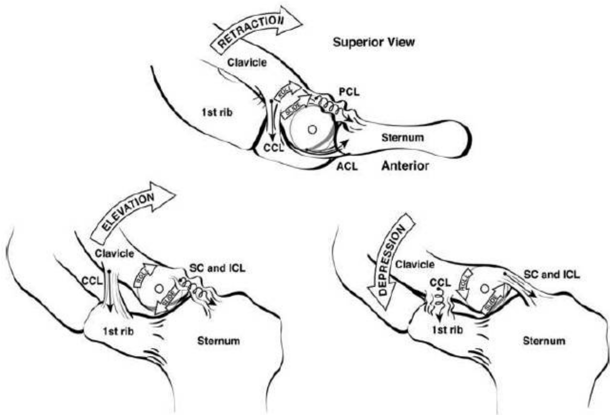


**Figure 4 –** ***Schematic drawing noting the tension and laxity in the CCL during ranges of motion. After Neumann DA and Wong DL, Kinesiology of the musculoskeletal system: foundations for physical rehabilitation, Mosby, St. Louis, 2002 [17]. The measurement of the CCL is noted as the straight arrows in this figure.***

The ligament became taut with increased internal rotation but never reached a point of maximal tautness. With small degrees of external rotation, the ligament showed little to no movement. However, under extreme degrees of external rotation the ligament became taut and even began to pull the first rib laterally. With flexion and extension, the ligament became taut in both instances to a similar degree with rotational movements with the most laxity occurring in anatomical position. Table 2 lists details of the observations made of the CCL during various ranges of motion (Figure 4). No statistical differences were noted between gender or sides.

**Table 2 –** ***Presence or absence of CCL and observations during ranges of motion. >$90^0$ implies scapular rotation necessary***

| Body Number | Gender | Side of Body | Presence | Abduction | Adduction | Internal Rotation | External Rotation | Flexion | Extension | Anatomical Position |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | *M* | Left | Present | taut $90^0$ | lax | taut | lax | taut | taut | Lax |
| | | Right | Present | taut $90^0$ | lax | taut | lax | taut | taut | Lax |
| 2. | *F* | Left | unable to evaluate due to previous dissection | | | | | | | |
| | | Right | Present | unable to evaluate due to fractured humerus | | | | | | |
| 3. | *M* | Left | unable to evaluate due to previous dissection | | | | | | | |
| | | Right | Present | taut >$90^0$ | lax | taut | taut | taut | taut | lax |
| 4. | *M* | Left | Present | taut $90^0$ | lax | taut | lax | taut | taut | lax |
| | | Right | Present | taut >$90^0$ | lax | taut | lax | taut | taut | lax |
| 5. | *F* | Left | Present | taut $90^0$ | lax | taut | lax | taut | taut | lax |
| | | Right | Present | taut $90^0$ | lax | taut | lax | taut | taut | lax |
| 6. | *M* | Left | Present | taut $75^0$ | lax | taut | lax | taut | taut | lax |
| | | Right | Present | taut $75^0$ | lax | taut | lax | taut | taut | lax |
| 7. | *F* | Left | Absent | | | | | | | |
| | | Right | Two parts | taut $90^0$ | lax | taut | lax | taut | taut | lax |
| 8. | *F* | Left | Present: two parts split by subclavius tendon | taut $90^0$ | lax | taut | lax | taut | taut | lax |
| | | Right | Present | taut $90^0$ | lax | taut | lax | taut | taut | lax |

| Body Number | Gender | Side of Body | Presence | Abduction | Adduction | Internal Rotation | External Rotation | Flexion | Extension | Anatomical Position |
|---|---|---|---|---|---|---|---|---|---|---|
| 9. | *M* | Left | Present | taut $90^0$ | lax | taut | lax | taut | taut | lax |
| | | Right | Absent | | | | | | | |
| 10. | *M* | Left | Present | taut $>90^0$ | lax | taut | taut | taut | taut | lax |
| | | Right | Present | taut $>90^0$ | lax | taut | taut | taut | taut | lax |

## Discussion

A CCL was found in the majority of our specimens and only in the minority of specimens did we observe more than one part of this structure (two sides). Contrarily, Cave AJ [5] stated that a bursa found between the two parts of the CCL suggested separate functions of these parts and we did not identify any bursa associated with this ligament in any specimen. To support the findings of Cave AJ [5], Williams PL [3] stated that the CCL is formed by anterior and posterior laminae with the posterior portion being shorter. In support of our findings, Woodburne RT and Burkel WE [4] concluded that this is a single structure and that the subclavius muscle inserts anterior to it although we did identify one side where the tendon of this muscle pierced the CCL. Williams PL [3] further published that this ligament always attached to the first rib and its costal cartilage. In the present study, this was not always the case as some specimens revealed a ligament that attached only to the first costal cartilage.

Functionally, Kapandji IA [14] found that the CCL limits the medial part of the clavicle from sliding inferiorly and laterally when the lateral aspect of the clavicle is abducted.

We found that the tautness of the CCL increased as the degree of abduction increased. Internal rotation of the arm translated into medial shift of the clavicle, raising the clavicle away from the first rib creating tension in the ligament. With small degrees of external rotation, the ligament showed little to no movement. However, under extreme degrees of external rotation the CCL became taut and even began to pull the first rib laterally.

Interestingly, Bearn JG [6], in a study of the sternoclavicular joint, cut the CCL and upper two costal cartilages and did not appreciate any increase in the depression of the lateral end of the clavicle with loadings up to 20 lbs.

Clinically, Pendergrass EP and Hodes PJ [15] found that the CCL might cause a deep impression on the undersurface of the clavicle, which may be mistakenly identified as a lesion on radiographs.

Interestingly, Sanders RJ and Hammond SL [12] reported 21 patients with subclavian vein obstruction that were treated with transaxillary first rib resection and venolysis. These authors concluded that subclavian vein compression in these patients was due to the CCL or the subclavius tendon as symptoms were improved following division of these structures.

Krutchen AE *et al.* [8] opined that subclavian vein catheters and pacing leads (Figure 3) malfunction not due to compression between the first rib and the clavicle but rather due to entrapment in the subclavius muscle-costoclavicular ligament complex and that this can be avoided by employing fluoroscopically guided puncture techniques that enter the subclavian vein lateral to the first rib. Although we did not observe ossification in any of our specimens, this pathology has rarely been found [16].

## Conclusions

It is our hope that these data will be of use to clinicians who deal with pathology of the sternoclavicular region.

The CCL is intimately related to the subclavian vein and this should be kept in mind during invasive procedures of this region.

Functionally, the CCL restricts a variety of motions of the sternoclavicular joint.

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