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STUDY OF STRUCTURE OF CORACOCLAVICULAR LIGAMENT TO CORRELATE ITS' ROLE IN WEIGHT TRANSMISSION

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ABSTRACT

AIMS AND OBJECTIVES: The present study was undertaken to correlate structure of coracoclavicular ligament with its' role in transmission of weight from upper limb to the axial skeleton.The study was done for the morphology of coracoclavicular ligament (parts, attachments, direction of fibers and thickness) and to look for any variation in morphology of the ligament.

MATERIAL AND METHOD: Sixty coracoclavicular ligaments were studied on right and left sides of thirty cadavers donated at the Anatomy department, Pramukhswami Medical College, Karamsad. Coracoclavicular ligament was studied for morphology of its conoid and trapezoid parts, attachments of both and variations.

RESULT: Anteriorly trapezoid part of the coracoclavicular ligament overlapped the lateral half of conoid part of. (Plate- 1). In all 60 cases, trapezoid fibers were directed upwards and laterally and it was quadrangular in shape. This component was thinner than conoid part. As compared to trapezoid part, conoid part was thick laterally and inferiorly. The fibers of conoid part were directed upwards and medially. A vertical slit like gap was observed between these two parts. In posterior view (Plate-4), conoid part showed continuity with trapezoid part. The line of attachment of the coracoclavicular ligament on coracoid process was inverted L shaped (Plate-2). On clavicle the line of attachment was delta shaped. In four specimens, the trapezoid part of coracoclavicular ligament was grossly giving appearance of muscular tissue (Plate-5). Out of 60 specimens, in 20 specimens, the coracoclavicular ligament was continuous with the suprascapular ligament (Plate- 6).
In four cases, from inferior most attachment of coracoclavicular ligament at the root of coracoid process, an extra band was observed. (Plate-7). In two cases, extra band of coracoclavicular ligament was found anteriorly (Plate- 8).

CONCLUSION: Conoid ligament was much thicker as compared to trapezoid ligament which indicates that, the conoid ligament was more important in weight transmission and for providing stability to acromioclavicular joint. The fibers of conoid ligament were directed upwards and medially. These suggest that, the conoid ligament transmits weight of upper limb upwards and medially from coracoid process to clavicle. Postero-medially, the fibers of conoid ligament were twisted, these twisted fibers suggest the role of the ligament in movements of pectoral girdle and in providing stability to acromioclavicular joint. Continuity of conoid part with suprascapular ligament

enhances the thickness of the supra scapular ligament and may reduce the size of the suprascapular notch. This may cause entrapment of suprascapular nerve and vessels. Variations were more commonly related with conoid ligament than trapezoid ligament. Among these variations the continuity of coracoclavicular ligament with suprascapular ligament was most common. In present study, the age of cadavers range between 50-89 years. There was not a single incidence of ossification of the ligament or presence of cartilaginous nodule within this ligament. Similarly, coracoclavicular joint was not found in any of them. Therefore, it could be deduced that coracoclavicular joint could be found at any age and occurrence of this joint was not an effect of the aging process.

INTRODUCTION:

It is considered that clavicle receives weight through coracoclavicular ligament (Salter et al., 1987). This ligament connects the clavicle to coracoid process of scapula. It is the main bond of union for acromioclavicular joint. It has two parts, conoid and trapezoid ligament. Conoid ligament is attached above to the conoid tubercle on the inferior surface of lateral third of clavicle and below to the root of coracoid process of scapula. Trapezoid ligament is attached above to the trapezoid ridge on inferior surface of lateral third of clavicle and below to the superior surface of coracoid process of scapula. Weight of upper limb is transmitted to clavicle through the coracoclavicular ligament which in turn transmits it to sternum via the sternoclavicular joint.

According to Fukuda et al. (1986), clavicle and coracoclavicular ligament acts as fulcrum during movements of pectoral girdle. The coracoclavicular ligament helps the scapula and upper limb to remain suspended from the clavicle. The coracoclavicular ligament is the main bond of union for acromioclavicular joint. It provides great stability to acromioclavicular joint and prevents its displacement.

Thus, coracoclavicular ligament and clavicle both are very important structures in transmitting weight of upper limb to axial skeleton.

MATERIAL AND METHOD:

Sixty coracoclavicular ligaments were studied on right and left sides of thirty cadavers donated at the Anatomy department, Pramukhswami Medical College, Karamsad.

Sixty coracoclavicular ligaments were dissected from anterior and posterior aspects of thirty cadavers.

- ➢ For anterior exposure, skin and fascia of pectoral region were removed. Pectoralis major muscle was cut from origin and reflected laterally. Clavicular fibers of deltoid muscle were also removed. Pectoralis minor muscle was kept intact. Its insertion on coracoid process was defined and was kept intact as a landmark for the ligament. Using this landmark the scapular attachment of the coracoclavicular ligament was defined. Above the insertion of pectoralis minor, the ligament was identified and it was cleaned anteriorly.
- ➢ For posterior exposure, skin and fascia of scapular region were removed. Clavicular and scapular attachments of trapezius muscle were cut. Supraspinatous muscle was removed from fossa to get proper view of coracoclavicular ligament from posterior aspect.

Coracoclavicular ligament was studied for morphology of its conoid and trapezoid parts. This included,

1) Direction of fibers from coracoid process to clavicle.
2) Thickness of both these parts.
3) Continuity of conoid part with trapezoid part.
4) Any morphological and structural variations like,

- ➢ Presence of muscle fibers.
- ➢ Presence of cartilage or bony nodules within ligament.
- ➢ Extra extension of coracoclavicular ligament in medial or lateral directions.

For presence of muscle fibers, tissue was processed; cross and longitudinal sections were taken. Sections were stained with Masson's trichrome to differentiate collagen fibers and muscle fibers.

5) Line of attachment of these two parts of ligament was studied on superior surface coracoid process and on its root. Similarly line of attachment was traced on inferior surface of clavicle. This provided proper idea of arrangement of fibers of the two parts of this ligament.

ABBREVIATIONS :

A – Acromion process of scapula
Ant. – Anterior
CCL – Coracoclavicular ligament
CL – Clavicle
Con. - Conoid ligament
Cor. - Coracoid process of scapula
COR. A. Lig. - Coracoacromion ligament
cs. cl. lig. - area for attachment of costoclavicular ligament
Dlt. - Deltoid muscle
F – Female
Inf. – Inferior
Lat. - Lateral
M – Male
Med. - Medial
Pst. – Posterior
Sp.Sc. - Spine of scapula
Sup. S. - Supraspinatous muscle
Trp. - Trapezoid ligament
Trpz – Trapezoid ridge

RESULT:

Anteriorly trapezoid part of the coracoclavicular ligament was seen clearly and it overlapped the lateral half of conoid part of this ligament. (Plate- 1).

In all 60 cases, trapezoid fibers were directed upwards and laterally and it was quadrangular in shape. This component was thinner than conoid part and it was like a thin sheet. As compared to trapezoid part, conoid part was thick laterally and inferiorly (near the coracoid process). The fibers of conoid part were directed upwards and medially. A vertical slit like gap was observed between these two parts.

In posterior view (Plate- 4), conoid part showed continuity with trapezoid part.

The line of attachment of the coracoclavicular ligament on coracoid process was inverted L shaped (Plate- 2).

The horizontal limb of L (Line b in Plate- 2) was marked on superior surface of coracoid process of scapula and it provides attachment to trapezoid part of the coracoclavicular ligament, while the vertical limb of L (Line a, in Plate- 2) extended up to the root of coracoid process and it provided attachment to conoid part of coracoclavicular ligament. The angle between two limbs was directed posteriorly**.** The conoid part was thickest near the angle.

On clavicle the line of attachment was delta shaped, the conoid part was attached to the conoid tubercle and area in front of it and the trapezoid part was attached to the trapezoid ridge going forwards and laterally (Plate- 3).

The continuity of conoid and trapezoid parts of the ligament was seen clearly from the posterior aspect (Plate- 4).

This ligament was closely related anteriorly with deltoid muscle, posteriorly with trapezius muscle, and laterally with coracoacromion ligament (Plate- 5).

In four specimens, the trapezoid part of coracoclavicular ligament was grossly giving appearance of muscular tissue (Plate- 5). Histological findings indicated absence of muscle fibers in that specimen**.**

Apart from that, cartilage and bony nodules were absent in all 60 coracoclavicular ligaments.

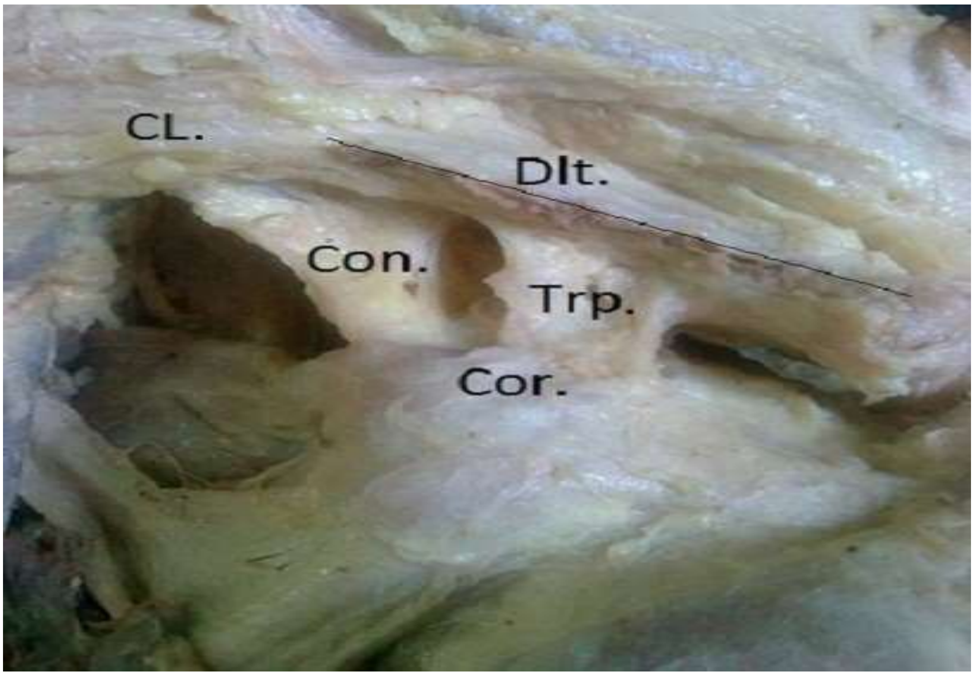

Plate - 1: Anterior view of left coracoclavicular ligament of male cadaver (14/08).

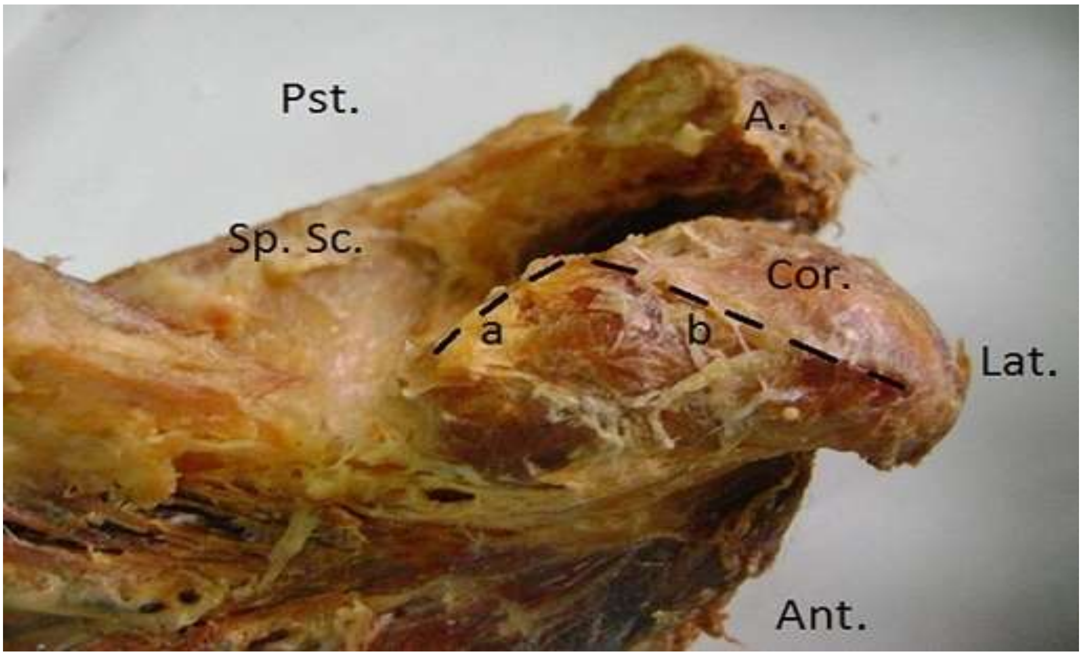

Plate - 2: Line of attachment of coracoclavicular ligament on coracoid process of left scapula . a – Line of attachment of conoid ligament and b – Line of attachment of trapezoid ligament.

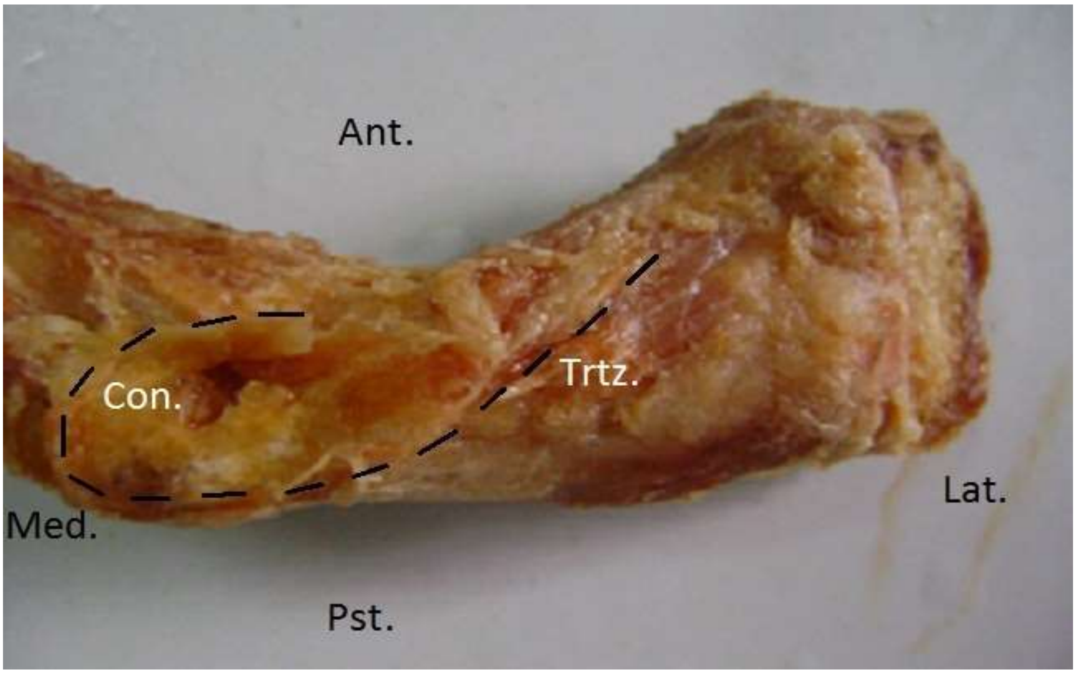

Plate - 3: Inferior surface of lateral third of left clavicle showing line of attachment of coracoclavicular ligament.

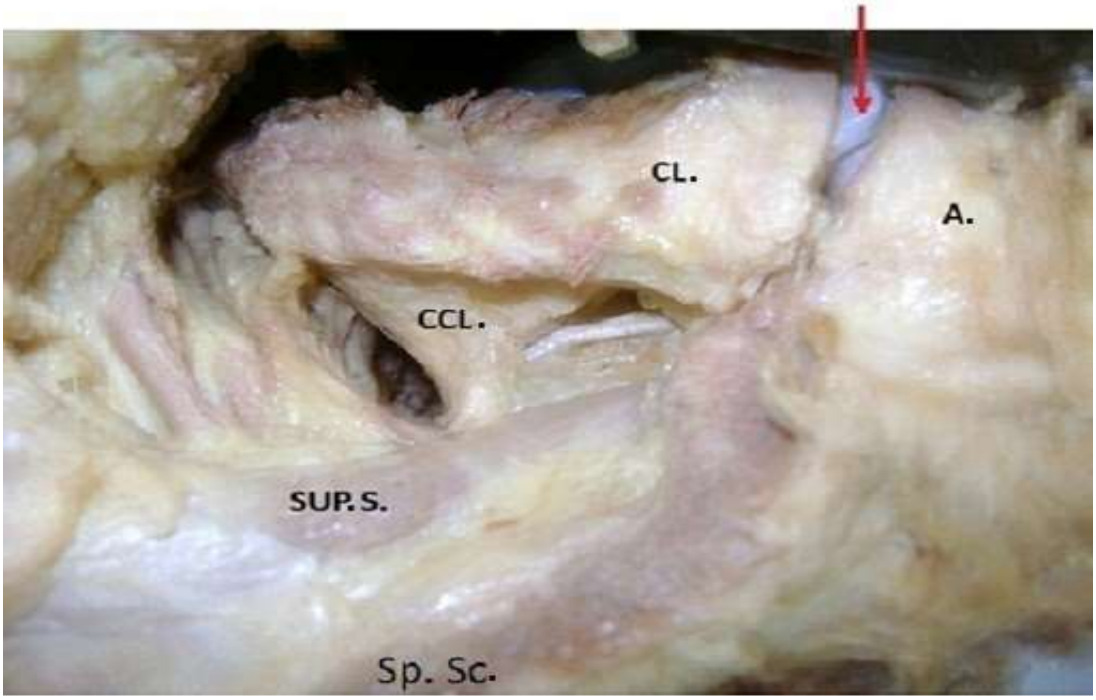

Plate - 4: Posterior view of right coracoclavicular ligament in male cadaver (17/08), red arrow shows position of acromioclavicular joint.

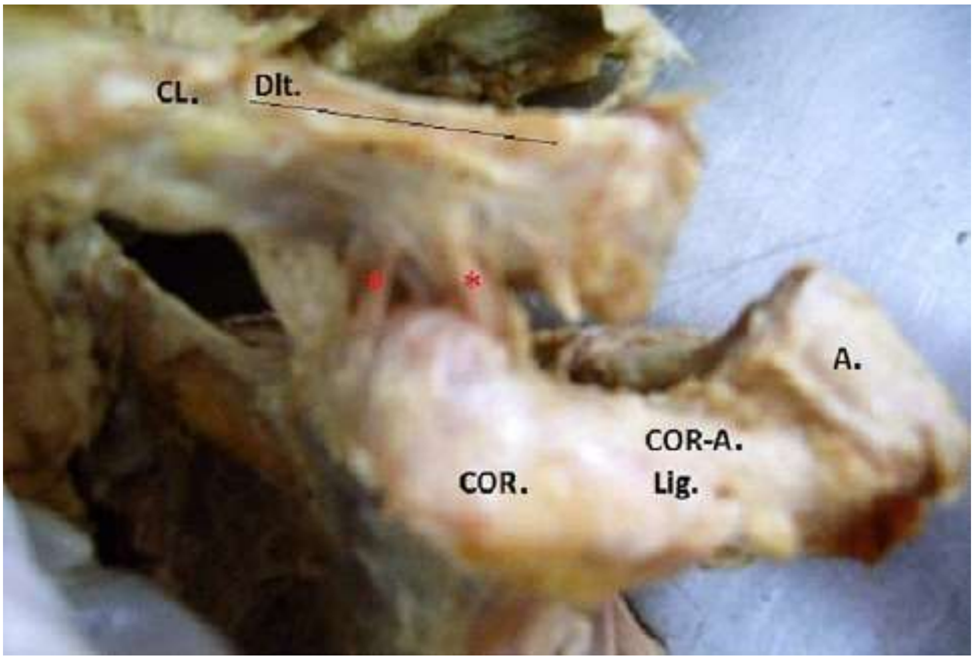

Plate - 5: Anterior view of left coracoclavicular ligament in male cadaver (18/08), red asterisk marks show trapezoid ligament which is grossly looking like muscle tissue.

Variations in the structure of coracoclavicular ligament :-

Arrow mark in plate- 6 shows continuity of suprascapular ligament with the conoid part of coracoclavicular ligament. Suprascapular vessels and nerve were located deep to this ligament. The posterior view of coracoclavicular ligament showed twisted fibers connecting conoid and trapezoid part of this ligament. Out of 60 specimens, in 20 specimens, the coracoclavicular ligament was continuous with the suprascapular ligament (Plate- 6).

In four cases, from inferior most attachment of coracoclavicular ligament at the root of coracoid process, an extra band was observed which was running upwards and laterally crossing the main ligament posteriorly and attached to the inferior surface of clavicle lateral to the attachment of coracoclavicular ligament (Plate- 7).

In two cases, extra band of coracoclavicular ligament was found anteriorly (Plate- 8). This extra band was situated medial to the conoid part of coracoclavicular ligament, directed upwards and medially. It was attached on root of coracoid process below the attachment of conoid part of the ligament. On clavicle, it was attached on inferior surface medial to the conoid tubercle.

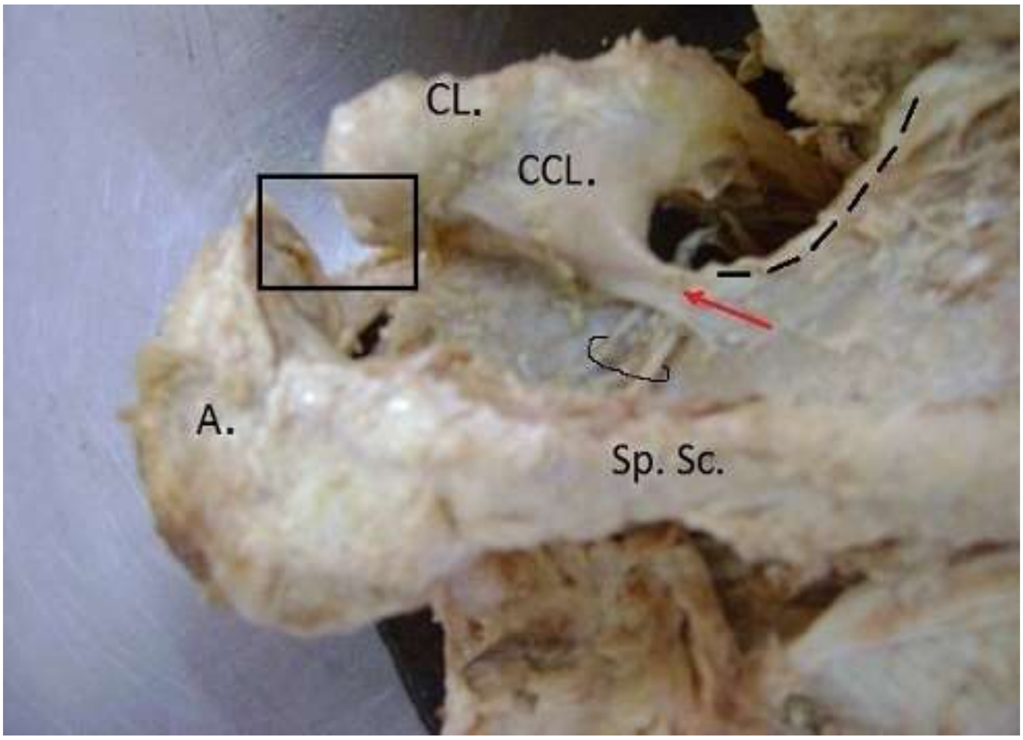

Plate - 6: Posterior view of left coracoclavicular ligament in male cadaver (18/08). Coracoclavicular ligament is continuous with suprascapular ligament. Black rectangle shows acromioclavicular joint. Encircled area shows suprascapular nerve and vessels passing deep to red arrow marked suprascapular ligament. Interrupted line shows superior border of the scapula.

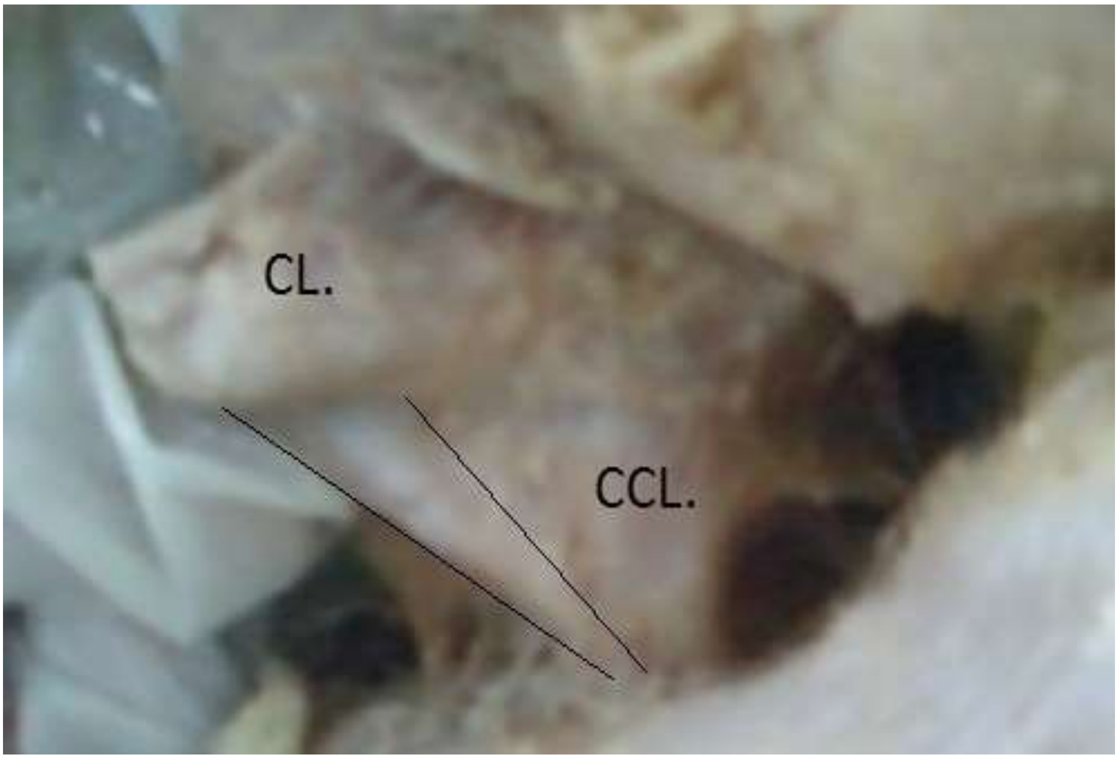

Plate - 7: Posterior view of left coracoclavicular ligament showing extra fascicle, in male cadaver (3/09). The area between two black lines shows extra fascicle.

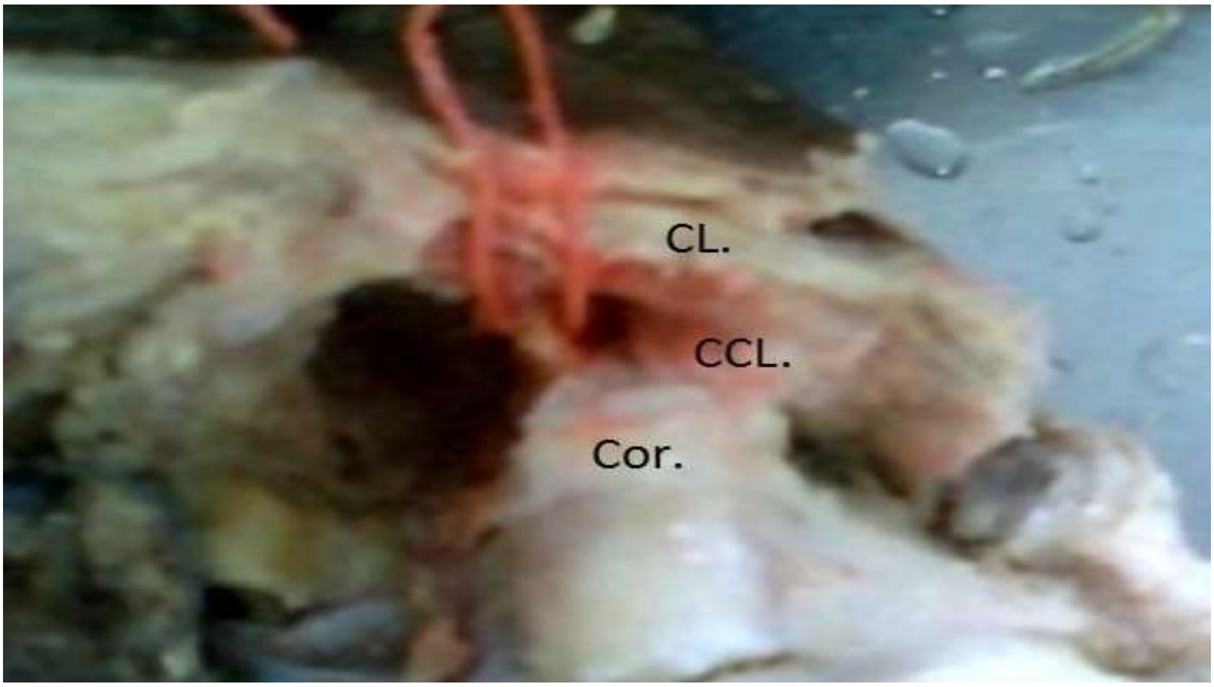

Plate - 8: Anterior view of left coracoclavicular ligament showing extra band (encircled by red thread), in male cadaver (22/10).

DISCUSSION:

Coracoclavicular ligament connects the clavicle and the coracoid process of scapula.

Though separate from the acromioclavicular joint it is a most efficient accessory ligament, maintaining apposition of the clavicle to the acromion process of scapula (4). Injuries to the acromioclavicular joint are common. In acromioclavicular dislocation, the coracoclavicular ligament is torn and scapula falls away from the clavicle.

Abbott and Lucas (1954) mentioned that the stability of acromioclavicular joint is provided by strong coracoclavicular ligament. The trapezoid and conoid parts of this ligament prevents medial displacement of scapula on clavicle and superior and posterior dislocation of clavicle at acromioclavicular joint.

Fukuda et al. (1986) and Peat (1986) had also described the role of coracoclavicular ligament in providing stability to acromioclavicular joint. Fukuda et al. (1986) stated that injuries to the acromioclavicular joint are common. These injuries might result in instability, subluxation or dislocation of the joint. The coracoclavicular ligament provides vertical stability to the acromioclavicular joint. Conoid part of the ligament is more important than the trapezoid part in providing stability to this joint. It prevents anterior and superior displacement of clavicle at acromioclavicular joint. Conoid ligament contributes the major amount of constraint with larger amount of

displacements. Among the two parts of coracoclavicular ligament, the trapezoid part is the major constraint to axial compressive forces on the joint, while the conoid part has a much larger role in most other directions of loading.

Peat (1986) mentioned the role of coracoclavicular ligament in providing stability to acromioclavicular joint. The conoid ligament limits upward movement of clavicle on acromion. It provides vertical stability to the joint and prevents superior dislocation of acromioclavicular joint. He described that, a fall on outstretched hand would tend to drive the acromion under the clavicle, but this over-riding is resisted by the trapezoid ligament. Therefore, coracoclavicular ligament is the main stabilizer for acromioclavicular joint and it suspends scapula from clavicle. Coracoclavicular ligament transmits force of superior fibers of trapezius to scapula.

However, Salter et al. (1987) differed from them and described the trapezoid part as the main component in preventing upward displacement of the clavicle. So, their views differed from above descriptions, in which conoid ligament is more important to provide vertical stability to acromioclavicular joint.

Seade et al. (2008) mentioned that both parts of coracoclavicular ligament provide vertical stability to acromioclavicular joint and trapezoid ligament prevents compression of the joint.

➢ Thus, above descriptions proved the role of both components of coracoclavicular ligament in providing stability to acromioclavicular joint.

Acromioclavicular joint is a joint of pectoral girdle. According to Gray's Anatomy (2008), movements at the acromioclavicular joint are like those of the sternoclavicular joint. Axial rotation of clavicle occurs 30 degrees at each of these two joints, which permits total 60 degrees of scapular rotation. Angulations of clavicle with scapula occur during elevation, depression, protraction and retraction. During angulations and rotation of clavicle at acromioclavicular joint, the coracoclavicular ligament becomes tense.

Therefore, coracoclavicular ligament plays important role during movements of shoulder (pectoral) girdle at acromioclavicular joint.

Inman and Saunders (1946) mentioned that the shoulder constitutes a complex mechanism, which involves sternoclavicular joint, acromioclavicular joint, glenohumeral joint as well as movement of scapula on the thoracic cage. These all joints contribute to the total movement of the shoulder. This harmony of movement is called scapulo-humeral rhythm. If any of these component is deranged, then there will be break in this harmony of rhythm. Elevation of upper limb occurs during flexion as well as during abduction at the shoulder joint. During elevation of shoulder, movements occurring at glenohumeral articulations are simultaneously accompanied by scapulothoracic movements. After 30 degrees of abduction or 60 degrees of forward flexion of shoulder, the relationship of scapular to humeral motion remains constant. Thereafter a ratio of two of humeral motion to one of scapular motion occurs. Between 30 to 170 degrees of abduction, for every 15 degrees of motion, 10 degrees occur at glenohumeral joint and 5 degrees by rotation of scapula on thorax. Scapular and humeral motion are simultaneously continuous. Out of 180 degrees of abduction at shoulder joint, 120 degrees occur due to glenohumeral movement and 60 degrees due to scapular rotation. This scapular rotation occurs at sternoclavicular and acromioclavicular joints. First 90 degrees of abduction is accompanied by elevation of clavicle at sternoclavicular joint. The clavicle is rigidly attached to the scapula through the coracoclavicular ligament. Lengthening of coracoclavicular ligament is necessary for movements at acromioclavicular joint during elevation of arm. A direct relationship was found between the line of attachment (trapezoid line and conoid tubercle) of these ligaments, the amount of clavicular rotation, the extent of relative lengthening of this ligament and scapular rotation. Thus, for total 60 degrees of scapular rotation, the first 30 degrees are due to the elevation of clavicle as a whole by movement at the sternoclavicular joint and the second 30 degrees are permitted at the acromioclavicular joint by clavicular rotation and elongation of coracoclavicular ligaments. Hence coracoclavicular ligament permits the clavicle to act as a crankshaft and allows half of the scapular movement.

➢ Thus, Coracoclavicular ligament acts as an axis for rotation of clavicle.

Abbott and Lucas (1954) mentioned role of coracoclavicular ligament during shoulder abduction. As the scapula rotates during abduction of arm, the coracoid process moves downwards. The coracoclavicular ligament permits the clavicle to rotate around its long axis. This rotation causes elongation of coracoclavicular ligament.

Fukuda et al. (1986) had mentioned the role of coracoclavicular ligament during movements of pectoral girdle. Conoid ligament acts as a fulcrum during anterior axial rotation of the clavicle. With increasing anterior axial rotation, the lengths of conoid and trapezoid ligament increase. During posterior axial rotation, the lengths of both components of the ligament increase. The conoid part increases in length during elevation, but during depression, lengths of both conoid and trapezoid ligament decrease. During distraction of clavicle from the acromion process of scapula, there is slight increase in length of conoid ligament, whereas during compression, length of only trapezoid ligament increases.

➢ This change in the length of these ligaments suggests that conoid and trapezoid ligaments play a very vital role during different movements of shoulder girdle.

Peat (1986) had observed that, during abduction of arm, coracoid process moves and the distance between clavicle and coracoid process increases. Conoid ligament becomes tense during backward axial rotation of clavicle as it acts as an axis for clavicular rotation.

According to Izadpanah et al. (2012), the length of coracoclavicular ligament depends upon the position of the patient and that of the shoulder. The length of conoid ligament increases from supine to sitting position and it further increases during shoulder abduction. The length of trapezoid part significantly decreases from supine to sitting position and it does not increase significantly during shoulder abduction. This suggests that conoid ligament plays important role during shoulder abduction.

Seo et al. (2012) described that the functions of conoid and trapezoid ligaments were reciprocal to each other during shoulder abduction. The length of conoid ligament gradually increases with increasing shoulder abduction, while the length of trapezoid ligament remains relatively constant during shoulder abduction and the ligament becomes lax at full shoulder abduction. According to him conoid ligament acts as a key restraint to prevent excessive retraction of the scapula during shoulder abduction.

These reports depict the role of coracoclavicular ligament during shoulder abduction and during movements of pectoral girdle.

According to Abbott and Lucas (1954) and Peat (1986), the coracoclavicular ligament transmits supporting force of trapezius muscle to the scapula.

- Thus, coracoclavicular ligament plays important role in providing stability to the acromioclavicular joint, for the movements of pectoral girdle, abduction of shoulder and weight transmition of upper limb to the clavicle.

Coracoclavicular ligament is an important structure transmitting weight of upper limb to axial skeleton. Due to above mentioned reasons, the study of structure of coracoclavicular ligament has been included in the present study.

Few authors have adequately described the coracoclavicular ligaments' anatomy, however a number of discrepancies exist in the anatomy literature. This study was done to examine the complex anatomy of the coracoclavicular ligaments and to correlate the anatomy with the function of weight transmition.

The role of coracoclavicular ligament in weight transmition of upper limb to clavicle, inspired to study structure of this ligament and further to correlate its structure with the function of weight transmition.

According to Gray's Anatomy (2008), the coracoclavicular ligament connects the clavicle and coracoid process of scapula. Its trapezoid and conoid parts are usually separated by fat or bursa. The trapezoid part is anterolateral to conoid part. It is broad, thin and quadrilateral. It is ascending slightly from the upper coracoid surface to the trapezoid line on the inferior clavicular surface. It is almost horizontal and its anterior border is free. It is posteriorly continuous with conoid part, forming an angle which is directed backwards. The conoid part is posteromedial to trapezoid part. It is dense and vertical triangular band. Its base is attached to the conoid tubercle of clavicle and inferiorly the apex is attached postero-medially to the root of the coracoid process of scapula, in front of scapular notch.

Findings of this study also correlate with this description of coracoclavicular ligament. We found the coracoclavicular ligament in two parts, conoid and trapezoid ligament (Plate-1). Anteriorly both parts were separated by a slit like gap, filled with fat or bursa (Plate-1). Anteriorly trapezoid part was seen clearly and it overlapped the lateral half of conoid part. The conoid ligament was attached above to the conoid tubercle on the inferior surface of clavicle and below to the root of coracoid process of scapula (Plate-2 and Plate-3). The fibers of conoid ligament were directed upwards and medially. These attachments and direction of fibers of conoid ligament suggest that, the conoid ligament transmits the weight of upper limb from coracoid process of scapula to the conoid tubercle of clavicle. The weight of upper limb is transmitted upwards and medially from coracoid process to clavicle. In present study the trapezoid ligament was attached above to the trapezoid ridge on the inferior surface of lateral one third of clavicle and below to the posterior half of superior surface of coracoid process of scapula (Plate-2 and Plate-3). Trapezoid fibers were directed upwards and laterally. Conoid ligament was much thicker as compared to trapezoid ligament. Thicker conoid part indicates that, the conoid ligament is more important in weight transmition and for providing stability to acromioclavicular joint. Conoid ligament was triangular in shape while the trapezoid ligament was quadrangular in shape. Posteriorly, conoid part was continuous with trapezoid part. The angle between the attachments of two parts on coracoid process was directed posteriorly (Plate-4). The conoid part was thickest near the angle. The triangular shape of conoid ligament with apex towards coracoid process and more thickness at the same point suggest that, fibers of this ligament diverge from coracoid process to conoid tubercle. Therefore, the area of attachment of ligament on coracoid process is less as compared to the area on clavicle. The fibers of conoid ligament are concentrated in less area of coracoid process. So, thickness of the ligament is more at this area and as the fibers diverge superiorly, thickness decreases and the area of attachment becomes more on clavicle. Postero-medially, the fibers of conoid ligament were twisted near this angle (Plate-4). According to Gray's Anatomy (2008), these twisted fibers suggest the role of the ligament in movements of pectoral girdle and in providing stability to acromioclavicular joint.

The structural variations in coracoclavicular ligament were found in literature by Roy (1959), Nalla and Asvat (1994), Cho and Kang (1998), Harris et al. (2001), Nicolaides et al. (2006), Paraskevas et al. (2009).

In the present study, the coracoclavicular ligament was continuous with suprascapular ligament in 20 specimens (33.33%) (Plate- 6). Suprascapular nerve was located deep to this ligament. Continuity of conoid part with suprascapular ligament enhances the thickness of the supra scapular ligament and may reduce the size of the suprascapular notch. This may cause entrapment of suprascapular nerve and vessels. Harris et al. (2001) had also found similar variation in the structure of coracoclavicular ligament. He mentioned that, the coracoid insertions of conoid ligaments showed high variance, with 33% being confluent with the lateral fibers of the superior transverse scapular ligament (Suprascapular ligament). Therefore, our findings of the present study (about this common variant of coracoclavicular ligament) are quantitatively similar to author's findings. So, the continuity of conoid ligament with suprascapular ligament might be the most common structural variation found in the coracoclavicular ligament.

In four cases (6.67%) of the present study, an extra band was observed, running upwards and laterally from inferior most attachment of coracoclavicular ligament (at the root of coracoid process) and crossing the main ligament posteriorly (Plate- 7). It was attached to the inferior surface of clavicle lateral to coracoclavicular ligament. Harris et al. (2001) had also found additional lateral fascicle in 15% of specimens. On the basis of his findings (on lateral most point of coracoclavicular ligament on clavicle) he decided that a safety margin of 15 mm should be kept intact to preserve the coracoclavicular ligament during distal clavicular resection. This aforesaid extra fascicle's attachment on clavicle might decrease this safety margin and there might be chances of cutting this extra band along with clavicle. This variation of the ligament is therefore of utmost importance to surgeons and should be kept in mind during distal clavicular resection.

In the present study, extra band of coracoclavicular ligament was found anteriorly in two cases (3.33%) (Plate- 8). This extra band was situated medial to the conoid part of coracoclavicular ligament, directed upwards and medially. It was attached on root of coracoid process below the attachment of conoid part of ligament. On clavicle, it was attached on inferior surface medial to the conoid tubercle.

➢ From the above, it can be observed that variations are more commonly related with conoid ligament than trapezoid ligament. And among these variations the continuity of coracoclavicular ligament with suprascapular ligament is most common.

The areas of attachment of coracoclavicular ligament may be covered by cartilage and form coracoclavicular joint, as described in Gray's Anatomy (2008). Several instances in literature [Roy (1959), Nalla and Asvat (1994), Cho and Kang (1998), Paraskevas et al. (2009)] mentions the presence of muscle fibers, cartilage or bony nodules within the coracoclavicular ligament. However, none of these were found in present study.

Various studies have been done to find out incidence of coracoclavicular joint in different populations. Roy (1959) has described bilateral coracoclavicular articulations in the Australian aboriginal. Nalla and Asvat (1994) has mentioned incidence of coracoclavicular joint in South African populations. The skeletons of their study were between 19-66 years. Cho and Kang (1998) have mentioned articular facets of the coracoclavicular joint in Koreans. The cadavers of their study were between 18-97 years. Paraskevas et al. (2009) found a case in which coracoclavicular joint wapresent in a 73 years old male skeleton of Caucasoid origin (Greece). Nicolaides et al. (2006) has described a case of painful shoulder in 42 year old right hand dominant Caucasian female due to degeneration of the coracoclavicular joint.

- In above studies no particular age group was focused. In present study, the age of cadavers range between 50-89 years. There was not a single incidence of ossification of the ligament or presence of cartilaginous nodule within this ligament. Similarly, coracoclavicular joint was not found in any of them. Therefore, it could be deduced that coracoclavicular joint could be found at any age and occurrence of this joint is not an effect of the aging process.
- Nalla and Asvat (1994) mentioned that the joint is more common in Asians than in Europeans or Africans. This statement is not in sync with our findings as we did not find this joint in any cadaver in this present study, which comprised solely of Asian population.

CONCLUSION:

In the present study, conoid and trapezoid parts of the coracoclavicular ligament showed the following features.

- Conoid ligament was much thicker as compared to trapezoid ligament. Thicker conoid part indicates that, the conoid ligament is more important in weight transmition and for providing stability to acromioclavicular joint. The fibers of conoid ligament were directed upwards and medially. These suggest that, the conoid ligament transmits weight of upper limb upwards and medially from coracoid process to clavicle. The conoid ligament was conical in shape. Postero-medially, the fibers of conoid ligament were twisted, these twisted fibers suggest the role of the ligament in movements of pectoral girdle and in providing stability to acromioclavicular joint.
- The trapezoid ligament was quadrangular in shape. Trapezoid fibers were directed upwards and laterally. Trapezoid ligament was thinner and weaker than conoid ligament.

These two parts showed continuity from the posterior aspect. While anteriorly there was a prominent groove between these two parts and this groove was occupied by loose connective tissue.

Among the two components of coracoclavicular ligament, conoid ligament plays a major role in weight transmition.

In the present study, following variations were found in the structure of coracoclavicular ligament.

- Out of 60 specimens, in 20 specimens, the conoid part of coracoclavicular ligament was continuous with the suprascapular ligament. Suprascapular vessels and nerve were located deep to this ligament. Continuity of conoid part with suprascapular ligament enhances the thickness of the supra scapular ligament and may reduce the size of the suprascapular notch. This may cause entrapment of suprascapular nerve and vessels.
- In four cases, from inferior most attachment of coracoclavicular ligament at the root of coracoid process, an extra band was observed which was running upwards and laterally crossing the main ligament posteriorly and attached to the inferior surface of clavicle lateral to the attachment of coracoclavicular ligament.
- In two cases, extra band of coracoclavicular ligament was found anteriorly. This extra band was situated medial to the conoid part of coracoclavicular ligament, directed upwards and medially. It was attached on root of coracoid process below the attachment of conoid part of the ligament. On clavicle, it was attached on inferior surface medial to the conoid tubercle.

Variations are more commonly related with conoid ligament than trapezoid ligament. Among these variations the continuity of coracoclavicular ligament with suprascapular ligament is most common.

- No muscle fibers were found in any of the coracoclavicular ligament.
- In present study, the age of cadavers range between 50-89 years. There was not a single incidence of ossification of the ligament or presence of cartilaginous nodule within this ligament. Similarly, coracoclavicular joint was not found in any of them. Therefore, it could be deduced that coracoclavicular joint could be found at any age and occurrence of this joint is not an effect of the aging process.

Increase in thickness of cortical bone medial to conoid tubercle till the level of thick bony plate near the medial end suggest that the clavicle receives force from upper limb at conoid tubercle through the coracoclavicular ligament. From conoid tubercle the weight is distributed to the cortical and cancellous bone till the attachment of costoclavicular ligament. Ultimately, cortical and cancellous bone sends major part of this force to costoclavicular ligament through thick bony plate. Remaining force from thick bony plate is transmitted medially to sternal end of clavicle, sternoclavicular joint and sternum.

In abducted arm, costoclavicular ligament is fully stretched. During this condition it acts as a medium to transmit the major amount of force from the thick bony plate to the first rib. Medial to this bony plate, the trabecular plates and cortical bone was very thin which suggest that they transmit less amount of force to the sternum through sternoclavicular joint.

Thus, segment III received force from upper limb that is transmitted through cortical bone and trabeculae of cancellous bone to the lateral end of segment I. Here, the force is bifurcated into two components. The major amount of force is transmitted through the bony plate and rest of the force is transmitted to the sternum through sternoclavicular joint.

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