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Anatomy Section

# Morphometric Study of Clavicular Facet of Coracoclavicular Joint in Adult Indian Population

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## ABSTRACT

**Introduction:** Anthropologists have used Coracoclavicular Joint (CCJ), a non-metric anatomical variant in population, as a marker for population migration from prehistoric times to present.

**Aim:** The aim of this osteological study was to determine the incidence and morphometry of articular facet of CCJ on conoid tubercle of clavicle in Indian population, as Indian studies are scanty and incomplete.

**Materials and Methods:** The study was done on 144 adult human clavicles (76 right and 68 left; 93 males and 51 females) collected from osteology museum in Department of Anatomy, Maulana Azad Medical College, New Delhi, India. The presence of articular facet on the conoid tubercle was determined and Maximum Antero-Posterior (MAPD) and maximum transverse diameter (MTD) was measured by digital vernier calliper. The incidence was compared on the basis of sex, side and with other osteological studies in the world. Statistical analysis was done using the Chi-Square test for nominal categorical data and student's t-test for normally distributed continuous variables in Microsoft Excel 2007 to assess the relationship between the examined variables.

**Results:** Articular facet on conoid tubercle was found in 8 cases (5.6%). Seven (9.2%) were present on the right side and one (1.5%) on the left side. Seven cases (7.5%) were present in males and one case (2%) was found in females. The facets were generally oval, with MAPD and MTD of 12.28 and 17.17 mm respectively. A significant side variation was present with right sided facet being more common. The left sided facet was more transversely elongated than right. In males, the facets were more elongated antero-posteriorly than in females.

**Conclusion:** The Indian population showed an incidence of 5.6%, which was comparable to other ethnic groups in world population. The morphometric and side differences could be attributed to the occupational factors and range of movements associated with the CCJ. The CCJ should be borne in mind as a differential diagnosis for thoracic outlet syndrome and in general for shoulder pain.

**Keywords:** Articular facet, Clavicle, Shoulder pain

## INTRODUCTION

Coracoclavicular Joint (CCJ), an anomalous synovial articulation between the conoid tubercle of the clavicle superiorly and the superior surface of the horizontal part of the coracoid process of the scapula inferiorly, is a well studied entity that has been used as an anthropological marker for human migration. Many authors have stated that an articular facet on the conoid tubercle or the cranio-medial surface of the coracoid surface indicates the existence of a coracoclavicular joint [1-3]. The shape of articular facet on the conoid tubercle varies from oval usually, with the long axis horizontally directed to circular [4-6].

The frequency of CCJ is highest in Mapuche native population (22.9%), followed by Central Asian (9.8-9.9%), Northwest Indian (9.7%) and South African population (9.4–10%) and is lowest in Southern European population (0.3%) [4]. The analysis of the global distribution of this anatomical variant provides a pattern that suggests that this trait arose long ago in Central Asia and that the farther one progresses away from this locus, the lower is the prevalence of the finding [7].

CCJ is not described in most textbooks, leading to lack of awareness in the general orthopaedic society. It is a rare but well-established cause of shoulder pain and upper-limb paresthesia. However, the actual incidence of symptomatic cases is grossly underestimated. It is being considered responsible for restriction of shoulder joint movements, degenerative changes of joints of pectoral girdle and undiagnosed shoulder pains [4,8-10].

The cause of CCJ is debatable, even though there have been many suggested explanations given such as developmental, environmental, occupational, congenital, genetic or age related [4].

Previous study by Kaur & Jit was done only on Northwest Indian (Punjabi) population, 24 years back and showed incidence of 9.7% which may not be a representative of whole Indian population [5].

## AIM

The present study was undertaken to find out the frequency of the articular facet on the conoid tubercle of the clavicles in an osteological sample pertaining to adult Indian population.

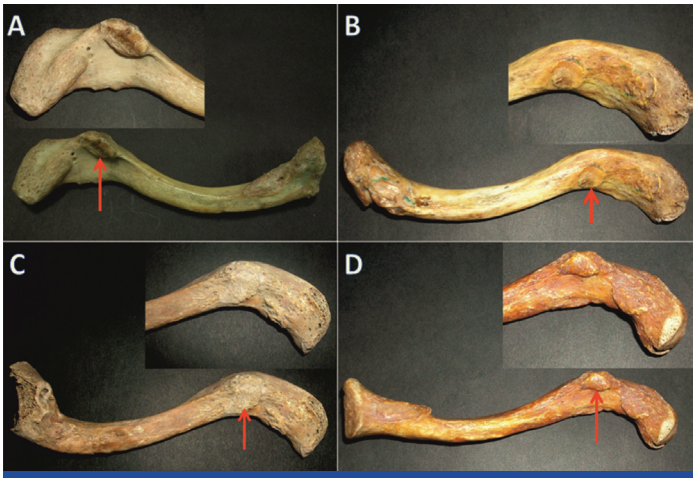
## MATERIALS AND METHODS

The study was conducted on a sample of 144 adult human clavicles (76 right and 68 left) collected from osteology museum in Department of Anatomy, Maulana Azad Medical College, New Delhi, India. Bones were documented for sex. The study material consisting of 93 male and 51 female sexes was segregated and assessed separately. The side of each bone was determined and the sample collected involved 76 bones of right side and 68 bones of left side. Clavicle exhibiting obscuring pathologies such as cortical bone deterioration were excluded from the study.

The presence of CCJ was determined by inspecting the occurrence of a distinct articular facet on the conoid tubercle. It was recorded according to the side, sex and was photographed using Kodak M1063 digital camera. The following measurements were taken on all articular facets using a digital vernier calliper: (1) maximum transverse diameter (MTD), (2) maximum antero-posterior diameter (MAPD).

## STATISTICAL ANALYSIS

Incidence of articular facet on conoid tubercle was calculated as percentage and statistical analysis was performed using the Chi-




**[Table/Fig-1]:** (a) Inferior view of left clavicle showing an articular facet on the conoid tubercle (indicated by red arrow) and (b-d) showing articular facet on the conoid tubercle of right clavicles (indicated by red arrow); (insight showing magnified view of articular facets)

Square test for nominal categorical data and Student's t-test for normally distributed continuous variables in Microsoft Excel 2007 to assess the relationship between the examined variables. A level of significance of $p < 0.05$ was used. All the observations and results were tabulated and compared with previously reported osteological studies.

## RESULTS

Out of 144 clavicles studied, articular facet on conoid tubercle was present in 8 (5.6%). Seven (9.2%) were present on the right side and 1 (1.5%) on the left side [Table/Fig-1]. The Chi-square results depict that articular facet is present more commonly on the right side with a significant side variation [Table/Fig-2].

In males, 7 (7.5%) clavicles showed the presence of articular facet on conoid tubercle and in females, only 1 (2%). The occurrence is not gender specific as they were statistically equal among males and females [Table/Fig-3].

The facets were typically oval, with horizontally directed long axis. The maximum transverse diameter and maximum antero-posterior diameter of articular facets was 17.17mm and 12.28mm respectively. Significant statistical difference was noted in the maximum transverse diameter in right (12.56 mm) and left (17.17mm) [Table/Fig-4], also in the maximum antero- posterior diameter in males (12.28 mm) and females (6.74mm) [Table/Fig-5]. Thus, articular facet in left is more transversely elongated than in right. Also in males, more elongated antero- posteriorly than in females.

| | Right (76) | Left (68) | Total (144) | Significance (p-value) |
|---|---|---|---|---|
| Presence of facets (no.) | 7 | 1 | 8 | 0.043 |
| Incidence (%) | 9.2% | 1.5% | 5.6% | |

**[Table/Fig 2]:** Incidence of articular facet on the conoid tubercle of clavicles in Indian Population on the basis of side and significance of this non-metric trait.

| | Male (93) | Female (51) | Total (144) | Significance (p-value) |
|---|---|---|---|---|
| Presence of facets (no.) | 7 | 1 | 8 | 0.163 |
| Incidence (%) | 7.5% | 2% | 5.6% | |

**[Table/Fig 3]:** Incidence of articular facet on the conoid tubercle of clavicles in Indian Population on the basis of sex and significance of this non-metric trait.

| Parameters | Right/Left | Measurement | Mean | Standard Deviation | Significance (p-value) |
|---|---|---|---|---|---|
| Max. Anterior Posterior Diameter | Right | 12.28 | 9.42 | 2.77 | 0.31 |
| | Left | 10.53 | 10.53 | 0 | |
| Max. Transverse Diameter | Right | 12.56 | 11.32 | 1.09 | 0.003 |
| | Left | 17.17 | 17.17 | 0 | |

**[Table/Fig 4]:** Comparison of articular facet on the conoid tubercle of clavicles in Indian Population on the basis of side.

| Parameters | Sex | Measurement | Mean | Standard Deviation | Significance (p-value) |
|---|---|---|---|---|---|
| Max. Anterior Posterior Diameter | Male | 12.28 | 10.69 | 1.52 | 0.02 |
| | Female | 6.74 | 6.74 | 0 | |
| Max. Transverse Diameter | Male | 17.17 | 12.86 | 3.74 | 0.46 |
| | Female | 12.56 | 12.56 | 0 | |

**[Table/Fig-5]:** Comparison of articular facet on the conoid tubercle of clavicles in Indian Population on the basis of sex.

## DISCUSSION

CCJ is a regular finding in the Gorilla and Gibbon, but in humans it is rare [11]. This entity was described in 1861 [6]. Since then, different authors have extensively studied the joint by osteological, cadaveric and radiological methods. Depending upon the approach of investigation and the population sample, a wide variation is noted in prevalence from 0.3% to 22.9% in osteological studies, 1.7% to 30% in cadaveric dissections and 0.04% to 3.0% in radiological studies [8].

| References | Year | Population | Sample size (n)* | Incidence (%) | Males (%) | Females (%) | Right (%) | Left (%) |
|---|---|---|---|---|---|---|---|---|
| Jaluvka [12] | 1956 | Czechoslovakia | 982 | 5.1 | - | - | - | - |
| Parsons [13] | 1916 | England | 282 | 1.4 | - | - | - | - |
| Bainbridge & Tarazaga [14] | 1956 | Southern Europe | 716 | 0.3 | - | - | - | - |
| Ray [15] | 1959 | Australian aboriginal | 584 | 0.7 | - | - | - | - |
| Abe [16] | 1964 | Japanese | 182 | 9.9 | - | - | - | - |
| Fischer et al., [17] | 1971 | French | 234 | 6.8 | - | - | - | - |
| Kaur and Jit [5] | 1991 | Northwest Indian | 2000 | 9.7 | 7.6 | 2.1 | - | - |
| Nalla & Asvat [3] | 1995 | South African (Black) | 360 | 9.4 | 5.6 | 3.9 | - | - |
| | | South African (White) | 120 | 10 | 5 | 5 | - | - |
| Cho & Kang [2] | 1998 | Korean | 204 | 9.8 | 5.9 | 3.9 | - | - |
| Gumina et al., [18] | 2002 | Italian | 1020 | 1.6 | 1.2 | 0.4 | - | - |
| Nehme et al., [6] | 2004 | French | 784 | 1.78 | 0.8 | 0.5 | - | - |
| Mariano et al., [4] | 2013 | Mapuche native (Chile) | 96 | 22.9 | 22.9 | - | 12.5 | 10.4 |
| Present study | 2015 | Indian | 144 | 5.6 | 7.5 | 2 | 9.2 | 1.5 |

**[Table/Fig-6]:** Comparison of incidence of CCJ in world population from osteological specimens.
* n= number of clavicles

Ethnic variations in the prevalence of CCJ joint have been reported in literature from osteological specimens [Table/Fig-6]. They are more common among the Central Asian particularly Chinese, Japanese and Koreans. They occur rarely among the Caucasians, Europeans, and Australians [4]. Cockshott suggested CCJ as a tool for understanding the pattern of human migration and plotted the relative frequency of CCJ on the global map to demonstrate the diminishing frequency with the increasing distance from the locus in Central Asia and related it to the Bering land bridge migration [7]. Many studies do not agree with this idea and indicated that negligible racial differences exists in the incidence of this joint [3,5]. The frequency reported in the Mapuche native of Chile (22.9%) is highest in osteological studies and completely overthrows this thought [4]. The incidence of articular facet of clavicle (representative of CCJ) in Indian population (5.6%) as reported in our study is comparable to the Czechoslovakian population (5.1%) reported by Jaluvka [12]. This data falls in the midst of the range (0.3% to 22.9%) reported in the various osteological studies of global population, suggesting that its presence may be related more to geographical migration rather than to genetic, environmental or evolutionary factors. The current study showed a lower incidence as compared to previous study done among northwest Indian population (9.7%) [5], this may be due to the fact that northwest India is near to the mainland of China as compared to whole of India.

The origin of CCJ is still questionable. According to the theory of the development of the shoulder girdle by Gegenbaur, the embryonic coracoid is connected with the clavicle by the cartilaginous procoracoid. In the course of normal development, this bone becomes fibrous and is ultimately transformed into the coracoclavicular ligaments. On their surface, in normal adults, nests of chondrocytes and even small nodules of cartilage are frequently seen. These chondrocytes upon stimulation (localised pressure and friction) may lead to abnormal joint formation or calcification. From the morphogenetic point of view, this theory can provide a suitable basis for the understanding of the congenital and acquired causes [9].

Lane [19] and Lewis [1] thought that this joint was an acquired joint seen in labourers and shoemakers, related to particular movements associated with their work. The highest frequency of CCJ reported in Mapuche ethnic group was associated with occupation or type of movements made by this population which corresponds to a population that collects food from the ground level [4]. But, Kaur and Jit concluded that there was no correlation between the existence of CCJ and particular occupations [5]. Nalla & Asvat hypothesized that the larger morphometry of the scapulae, clavicles and first ribs in individuals may restrict associated movements of the scapulae, resulting in the development of the coracoclavicular joint [3]. Cho and Kang correlated the appearance of coracoclavicular joint with the increase of age and raised the possibility that the joint may develop as a result of degenerative changes and is not related to the size of the scapulae or the slopes and heights of some coracoacromial arch elements [2]. Pillay, through family studies, had demonstrated that this anatomical feature is transmitted in a dominant manner and thus, is genetically transferred [20]. Kaur and Jit concluded from the absence of the facet in the fetuses, neonates, and young children that it is not a congenital anomaly [5].

Sexual differences was not statistically significant in the present study as well as in previous studies [2,3,5]. This shows that both sexes have equal chances of developing CCJ. But, Lewis reported that the joint was more common among males than females in a proportion of 11:1 [1].

The present study revealed asymmetry in the occurrence of CCJ, with right side being more common than left. Mariano [4] and Olotu [21] et al., found similar asymmetry in Mapuche (right – 12.5%, left – 10.4%) and Nigerian (right – 55.5%, left – 33.3%) populations respectively. In the present study, the articular facet on left clavicle is more transversely elongated than in right. Also, in males, more elongated antero- posteriorly than in females. Therefore, more articular area is present along an axis (transverse in left side and antero- posterior in males) which shows that more sliding and gliding movements can take place along these axes. Thus, these variations could be responsible for the different degree of movements associated with this joint.

Radiographically, the presence of this joint occurs when an articular facet on an enlarged conoid tubercle protrudes from the inferior aspect of the clavicle and a similar facet on the corresponding site on the coracoid process. The frequency of articular facets obtained from radiological studies are generally lower than osteological studies as an articular facet can exit on the conoid tubercle without forming a large bony process which can easily be missed on X-ray [17]. For example, Nehme et al., reported frequencies of 0.82% and 1.78% through radiological and osteological studies respectively in French population [6]. Some authors have reported the incidence of CCJ from dissections higher than that obtained from osteological materials [1,2,17]. This is due to the fact that an articular facet can exist without forming a prominent process or when a bony process exists without an articular facet [4]. However, since our study was carried out on dry bones, the proportion of clavicles with CCJ may be a slight underestimate.

The significance of the coracoclavicular joint is controversial. This joint is an anatomic variation seen on many radiographs, and is an incidental finding with little clinical significance. Many case studies describing the unnoticed significance have also been reported [22]. CCJ is rarely symptomatic. Whenever symptomatic, the most common symptom is shoulder pain. The mean age at presentation is 42 years, with a male: female ratio of 1.4:1. Involvement of brachial plexus is the most common pathophysiological clarification provided [8]. It is also been reported to be responsible for predisposition to humeral head fracture, cervicobrachial syndrome, thoracic outlet syndrome and shoulder joint pain radiating to the arm, neck which persists during rest and increase during exercise [4,23-25]. The presence of a CCJ hampers normal movements in the shoulder girdle, which are otherwise possible to a greater degree due to normal laxity of the coracoclavicular ligament complex. It is proposed that downward pull on the coracoid process generated by the anomalous CCJ, restricts the free upward movement of the acromion and leads to decreased space between the acromion and supraspinatus. This reduced functional space creates undue friction between these two structures, leading to impingement of the supraspinatus muscle. Undue repeated friction produced in this congested space can lead to shoulder pain and typical painful arc syndrome [8]. The presence of this joint also predisposes to degenerative changes of the sternoclavicular and acromioclavicular joints and that the joint itself has an affinity to undergo arthritic changes [9,10,18,26,27]. Rare symptoms include itching of the last four fingers, followed by transient paralysis of the hand, which are correctible with surgery [6,23]. An osteochondroma, post traumatic myositis ossificans around the shoulder may mimic pain due to CCJ [28]. Thus, knowledge of this joint is useful determining the cause of undiagnosed shoulder pains and its subsequent management.

## LIMITATIONS

The incidence of CCJ from dissections is generally higher than that obtained from osteological materials. Since, our study was carried out on dry bones, the proportion of clavicles with CCJ may be slightly undervalued. So, further correlation with actual dissection based study is needed. Also, the occupation of each individual

from whom the clavicle was obtained was not known. Therefore, the study could not provide a relationship between the type of work and CCJ.

## CONCLUSION

Coracoclavicular joint, a regressive joint, is not only an interesting occurrence but also compels us to explore out the incidence of this joint in various populations, its functional impact on pectoral girdle movements and its clinical implications.

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