ISSN 2063-5346

MORPHOMETRIC EVALUATION OF CLAVICLE AND ITS UTILITY IN THE MANAGEMENT OF CLAVICULAR FRACTURES

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Article History: Received: 01.02.2023 **Revised:** 07.03.2023 **Accepted:** 10.04.2023

Abstract

Background: The clavicle is a subcutaneous bone most frequently fractured at the junction of medial 2/3rd and lateral 1/3rd of its shaft. Surgical management requires detailed knowledge about the anatomy of the clavicle. The knowledge about the morphometry of clavicle is important for surgeons as well as orthopaedic surgeons.

Materials and Methods: The study was conducted in the Department of Anatomy, Career Institute of Medical Sciences & Hospital, Lucknow. 40 dry, adult, human clavicles from right and left sides each were studied using digital sliding calipers. Parameters like length, medial and lateral width, medial, lateral epiphyseal and medial diaphyseal diameters, medial and lateral bending radius were measured. Statistical analysis was done using SPSS software.

Results: Right clavicles were shorter than the left clavicle. The median diaphyseal diameter was significantly smaller than the medial and lateral epiphyseal diameter signifying the narrowness of the region. The results revealed that average lateral angle of right side and medial angle of the left side were significantly more.

Conclusion: Success of the clavicular fracture management depends largely on the morphometric knowledge of the clavicle. The morphometric values also may help the anthropologists as well as the forensic experts.

Keywords: Clavicle, Fractures, Morphometry, Bones

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DOI: 10.31838/ecb/2023.12.s1.078

Introduction

The clavicle is the first bone in the human body to begin intramembranous ossification directly from mesenchyme during the fifth week of fetal life [1]. The clavicle's S-shaped double curve, which is convex medially and concave laterally. This contouring allows the clavicle to serve as a strut for the upper extremity, while also protecting and allowing the passage of the axillary vessels and brachial plexus medially [2]. The lateral clavicle is anchored to the coracoid process by the coraco-clavicular ligament, composed of the lateral trapezoid and medial conoid parts. The static joint stabilizers are the AC ligaments, controlling the horizontal stability, and the CC ligament controlling the vertical stability. The dynamic stabilizers are the deltoid and trapezius muscles [3].

Morphology of the clavicle has been a subject of interest for researchers since long time. Clavicular morphology has been studied extensively by Orthopedic Surgeons for better management of clavicular fractures [4]. Human clavicle fractures are responsible for 3%-10% of all fractures and for 35-44% of fractures about the shoulder [5]. Middle-third fractures are responsible for 80% of all clavicular fractures while, fractures of the lateral and medial third of the clavicle account for 15% and 5%, respectively [6].

Fractures of the clavicle, which primarily occur in young males, constitute 2.6–4% of all fractures in adults [7]. The most frequent injury mechanism is a direct fall on the shoulder [8]. Fractures are often sustained during sports activities or traffic accidents [9]. The majority (69-82%) of fractures occur in the midshaft of the clavicle, followed by 12-26% in the lateral part and 2-6% in the medial part [10]. This can be anatomically explained by the fact that the medial and lateral parts of the clavicle are firmly secured by strong ligaments and muscles, whereas the middle part of the clavicle lacks any strong attachments and thus is more vulnerable to trauma. The muscle attachments often cause a dislocation of the major fragments in clavicle fractures and a shortening of the clavicle, particularly in midshaft fractures [11]. In a study of 122 consecutive patients, 87% clavicle injuries resulted from a fall onto the shoulder, 7% resulted from a direct blow, and 6% resulted from a fall onto an outstretched hand [12].

Although the clavicular fractures are treated conservatively, there is an increase in the incidence of cases of non-union as well as displaced fractures with conservative treatment. Fixations of clavicular fractures have shown improved benefits over the conservative methods. The design of fixation devices depends largely on the anatomical characteristics of the clavicle [13]. Hence the objective of the present study was to provide the detailed morphological data of the clavicle that could help orthopaedic surgeons in planning better management of clavicular fractures.

Materials and methods

This cross sectional study was conducted in the Department of Anatomy, Career Institute of Medical Sciences & Hospital, Lucknow. After the ethical approval 40 clavicles were from right side and left side each were collected for the study. Clavicle with broken ends and any other deformities were excluded from the study. Digital sliding caliper was used to take all the following morphometric measurements of clavicles:

- Clavicle length
- Medial width of clavicle
- Lateral width of clavicle
- Medial epiphyseal diameter
- Lateral epiphyseal diameter
- Median diaphyseal diameter
- Medial bending radius
- Lateral bending radius

Clavicle angles were measured following Parson's method [5]. The clavicle was first placed on a white board with right and left ends present in the same horizontal plane. Then the outline of the clavicle was drawn on the paper followed by marking of the midpoint of the acromial ends and sterna ends as points A and B respectively. These points were joined with a straight line. The central axis was a curved line and it was equidistant from the anterior and posterior border throughout the length of the clavicle. This curved line consisted of two convexities. Two deepest points on this curved line where the bone has maximum convexities were marked as points C and D. After this the points A and C, points C and D, points D and B were joined with a straight line resulting in the formation of two angles, one at the medial side and another at the lateral side of the bone respectively. These angles were measured twice with the help of protractor and a mean value

was taken. All the values were documented. Statistical analysis was done with SPSS 20 version. Students't test was applied to evaluate the difference of mean. A p value below 0.05 was statistically significant.

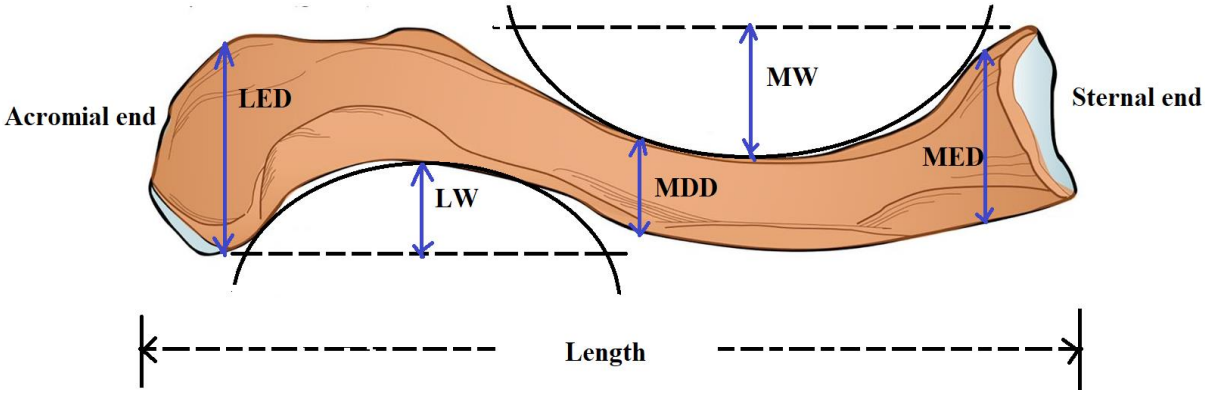

Figure 1: Measurements of clavicle. Clavicle length, Medial width of clavicle (MW), Lateral width of clavicle (LW), Medial epiphyseal diameter (MED), Lateral epiphyseal diameter (LED), Median diaphyseal diameter (MDD)

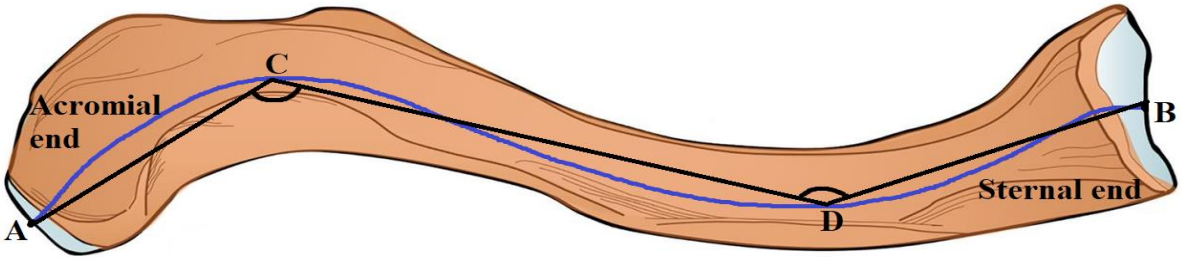

Figure 2: Measurements of clavicular angles

Result

Table 1: Morphometrical measurements of clavicle

Study parameters	Side		p value
	Right (Mean±SD)	Left (Mean±SD)	
Clavicle length (mm)	140.24±7.16	143.31±6.56	>0.05
Medial width of clavicle (mm)	11.51±2.19	13.11±3.41	>0.05
Lateral width of clavicle (mm)	8.82±1.2	7.32±1.02	>0.05
Medial epiphyseal diameter(mm)	20.47±4.11	21.63±3.91	>0.05
Lateral epiphyseal diameter (mm)	18.41±2.15	19.44±2.38	>0.05
Median epiphyseal diameter (mm)	7.97±2.41	8.69±3.01	>0.05
Medial bending radius (mm)	30.24±3.12	31.55±4.39	>0.05
Lateral bending radius (mm)	60.57±4.41	61.81±4.34	>0.05

Table 2: **M**easurements of clavicle angle

Study parameter	Clavicular angle	
	Medial (Mean ±SD)	Lateral (Mean ±SD)
Right side	142.2±3.02	151.68±1.66
Left side	150.18±4.15	148.35±2.73
p value	<0.05	<0.05

Discussion

The study describes the anatomy of the dry, human clavicles of unknown sex, age and gender. In the present study, mean length of the right clavicle was 140.24mm and left clavicle was 143.31 mm. Length of the clavicle was less when compared with previous studies done on dry clavicles in previous studies. The mean length of the clavicle in the present study was similar to the mean length obtained in studies done by Nalla *et al* [14], Huang *et al* [15], and Daruwalla *et al* [16]. In the present study the right clavicle was relatively shorter.

Sudha R [17] did a study on South Indian population and observed some contradictory findings. She found that right clavicle was longer than left. Studies done by Nagarachi K *et al* [18] and Singh G *et al* also found that the right sided clavicle was longer than left side [19].

In the present study, the lateral angle of right side and medial angle of left side were significantly larger. Contradictory to this Sudha R reported that medial angle was greater on the right side as compared to the left side [17]. Some similar findings were found by Haque MK *et al* [20], Kaur H *et al* [21] and Kaur K and Rathee SK [22]. They found that medial angle of left side was more than the right side.

Several studies have been conducted to determine whether there are any variations in length and angles of clavicle based on gender. Haque MK *et al* found that average length of left clavicle is more than right in both sexes [20].

Studies done by Kaur H *et al* among North-West Indians [21] and Kaur K and Rathee SK [22] among North Indian population found that lateral angle of left side was more in the both sexes. In a study done by Kumari S *et al* the lateral angle was more on left side [23].

Factors such as handedness and relative workload will affect the length of the clavicle. Median diaphyseal diameter was significantly less than the medial and lateral epiphyseal diameters. This justifies the fact that the middle third of the clavicle is the narrowest region making this region the common site for the fractures. Too much smaller median diaphyseal diameter means further smaller endomedullary canal and hence it may be a contraindication for intramedullary nailing as a treatment for mid-shaft fractures of the clavicle [24].

Conventionally clavicular fractures are being treated by conservative methods. Various authors have demonstrated the superiority of surgical method over the conservative management in clavicular fractures. Intramedullary approach preserves periosteal blood supply and hence has lesser chance of non-union [25]. Hence the detailed knowledge of clavicle anatomy becomes an essential aspect in the surgical management of clavicular fractures.

Conclusion

This study concludes that, the average length of the clavicle on the left side is more than the right side. The mean lateral angle of the right side of clavicle is more while mean medial angle in left side of clavicle is comparatively larger. Various factors including racial, genetic or mechanical factors could be responsible for this. The morphometric values also provide references to orthopaedic surgeons, anthropologists and forensic experts for detailed analysis and management in the respective sectors.

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