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## **Radiographic Analysis of Clavicular Length Variations in Nigerian Population: Its Application and Importance**

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### **ABSTRACT**

The dependence of morphometric values of human parts is very obvious in the construction, replacement and treatment of affected body parts, be it bones or soft tissues. The purpose of this study is to radiologically analyze the clavicular length variation and to extensively evaluate its application. The length of clavicle and its variation were evaluated using a total of 600 (Comprising 300 males and 300 females) anteroposterior radiographs of the chest with clearly and visibly defined clavicles. Clavicle devoid of fracture, dislocation, tumour and complete ossification were used. These radiographs were obtained from the archives of the Radiology Department: University of Port Harcourt Teaching Hospital, Braithwaite Memorial Specialist Hospital and Pixy Diagnostic center all located in Port Harcourt, Rivers State. Measurements were carried out on light x-ray box. Pencil and metric rule were used in tracing the line. Length of clavicle was measured in millimeters using a horizontal line drawn from the most medial point on the medial border of the sternal end to the most lateral point of the lateral border of the acromial end with the help of a metric rule. The data were analyzed using statistical package for social sciences (IBM® version 23 SPSS, Inc, Chicago, IL). Confidence interval was set at 95% and p-value  $\leq 0.05$  was considered significant. The result showed that the maximum length of male right clavicle was  $150.57 \pm 14.37$ mm and left was  $154.92 \pm 9.83$ mm. The maximum length for female right clavicle was  $137.92 \pm 8.76$ mm and left was  $142.44 \pm 16.18$ mm. The length of the clavicle showed statistical significant difference with varying correlating values for males and females ( $P < 0.001$ ). The left clavicles were found to be longer than the right clavicles. Male clavicles were also found to be significantly longer than that of the females. Variations observed in the clavicular osteometry and their lengths are widely used in clavicular surgeries and design of clavicular implant devices.

**Key Words:** Clavicles, Length, Radiography, Variation

### **INTRODUCTION**

The clavicle is a long bone with a shaft and two ends (Sternal and Acromial). It is known to be the most frequently fractured bone in the body.<sup>11</sup> Studies have shown that pre-knowledge of clavicular osteometry prior to surgery is essential and applicable in operative management of clavicular fracture.<sup>2,1,6</sup> Specific Data are required to enhance the choice of devices and to further minimize the episode of complications and failures during surgery.<sup>6</sup>

The length of the clavicle is a vital clavicular parameter used by orthopedic surgeons and orthopedic plate manufacturers to improve clavicular fracture management. Clavicular length variations have been observed in different population and individuals. The clavicle also differs in males and females; this is obvious in the length, thickness, curvature and smoothness. Many authors have observed that the clavicle is thicker and more prominently curved with outlined ridges in manual workers.<sup>7</sup> Studies have shown that the length of the clavicle is more on the left side than the right side and that

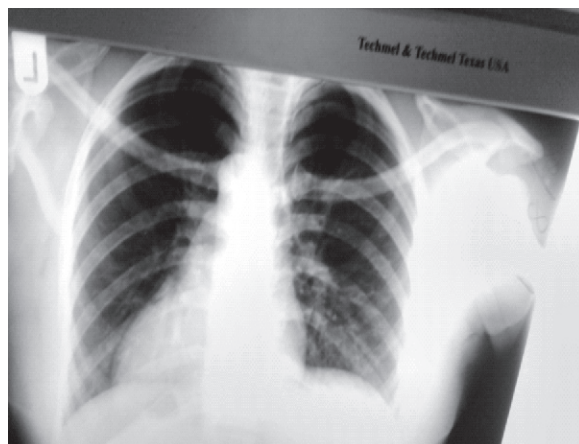
it is not always the same in all races.<sup>7</sup> Thus the present study is carried out to evaluate the variations in clavicular length in the Nigerian population and to assess some of its application in the management of clavicular fracture. Understanding the variations in the length of clavicle has been found to be very useful in intramedullary nailing and clavicular fracture management

### **MATERIALS AND METHODS**

A total of 600 standard anteroposterior radiographs (comprising 300 males and 300 female) of the chest with clearly and visibly defined clavicles were used for this study. These radiographs were ascertained by the resident radiologist to be visible and clear. The radiographs were sourced from the Radiology departments of University of Port Harcourt Teaching Hospital, Braithwaite Memorial Specialist Hospital and Pixy Diagnostic Center, all located in Port Harcourt, Rivers State Nigeria. Radiographs used were those that have completed ossification. The clavicles were devoid of fracture either healed or present. Bio data of the patients or subjects signified that they were all Nigerians aged between 25-70

years.

Materials used include: Radiographs of the chest with anteroposterior and axial view (600 radiographs), x-ray viewing box, pencil, metric rule. The radiographs were placed on the viewing box, lines were marked, and transparency was ensured for every tracing on the film.



Length of the clavicle: The maximum length of each clavicle was measured in millimeters from a horizontal line drawn from the most medial point on the medial border of the sternal end to the most lateral point of the lateral border of the acromial end with the help of a metric rule.



**Figure 1:** Radiographs showing measurement of clavicular length

### Data Analysis

The data were analyzed using statistical package for social sciences (IBM® version 23, SPSS, Inc Chicago, IL). For descriptive statistics, values were presented as mean and standard deviation, while student t-test was used to evaluate the sex differences in the mean values, paired sample t-test was used to evaluate the side difference in the mean values. Confidence level was set at 95% and p-value  $\leq 0.05$  was considered significant.

### RESULTS

The result presented are radiologic measurement of clavicular length, tables were used to represent and compare mean values of males and females. The descriptive characteristic and comparison of the sex differences in the left and right clavicular length are presented in tables 1-3.

Comparison of the present study that is mean length values with other studies are illustrated in table 4, table 5 shows comparison of length variation in different races.

### Length of the clavicle

The mean  $\pm$  (S.D) of right and left length of the clavicle for

the total population were  $144.26 \pm 13.47$ mm and  $148.68 \pm 14.76$ mm.

The mean  $\pm$  (S.D) for right and left clavicle for males were  $150.59 \pm 14.37$  and  $154.92 \pm 9.83$ . The mean  $\pm$  (S.D) for right and left clavicle length for females were  $137.92 \pm 8.76$ mm and  $142.44 \pm 16.18$  (table) 1. There was a statistical significant difference between males and females clavicle ( $P < 0.001$ ). The length of the clavicle of the right and left clavicle were significantly related with variations in estimation accuracies.

R. Vs L length [ $r = 0.640$ ,  $p < 0.001$ ] for the male clavicle, the length showed a significant difference with varying correlating value R. Vs L length = [ $r = 0.621$ ,  $P < 0.001$ ]. Female had a similar correlating value and significant difference, R. Vs L length [ $r = 0.622$ ,  $P < 0.001$ ]. Table 3 showed the Leven's analysis of variance where the right and left side clavicle in male were significantly longer when compared to that of females.

### Radiologic measurements

**Table .1:** Descriptive characteristics and inter-predictability of the clavicle (side)

Parameters	Total (N=600)			Male (N=300)			Female (N=300)		
	Mean $\pm$ S.D	R	P-value (Inf)	Mean $\pm$ S.D	r	P-value (Inf)	Mean $\pm$ S.D	r	P-value (Inf)
R. Length (mm)	$144.26 \pm 13.47$	0.640	<0.001 (S)	$150.59 \pm 14.37$	0.621	<0.001 (S)	$137.92 \pm 8.76$	0.622	<0.001 (S)
L. Length (mm)	$148.68 \pm 14.76$			$154.92 \pm 9.83$			$142.44 \pm 16.18$		

**Note:** R.=Right, L.=Left, N=Distribution, S.D=Standard deviation, r=Pearson's correlation, P-value = Probability value, Inf=Inference (S=Significant).

**Table 2:** Side difference evaluation using paired sample t-test

Parameters	Total (N=600)				Male (N=300)				Female (N=300)			
	Mean	S.D	t-value	P-value	Mean	S.D	t-value	P-value	Mean	S.D	t-value	P-value
R. Vs L Length (mm)	-4.42	12.03	-9.00	<0.001 (S)	-4.32	11.30	-6.63	<0.001 (S)	-4.52	12.74	-5.97	<0.001 (S)

**Table 3:** Sex difference evaluation using z-test

Parameter	Levene's Test for Equality of Variances			t-test for Equality of Means					
	F-value	P-value	Inf	df	M.D	S.E.D	t-value	P-value	Inf
R. Length (mm)	8.413	0.004	EVNA	494.15	12.677	0.971	13.050	<0.001	S
L. Length (mm)	0.198	0.657	EVA	598	12.480	1.093	11.419	<0.001	S

**Note:** F-value = Fisher's calculated value, EVA = Equal variance assumed, Inf. = Inference, EVNA = Equal variance not assumed, df = degree of freedom, t-value = t-test calculated value, P-value = Probability value, M.D = Mean difference, S.E.D = Standard error of the difference, C.I = Confidence interval, S = Significant, NS = Not Significant.

**Table 4:** Comparisons of radiologic measurement in the present with other studies Mean length of the clavicle

Authors	Population	R Male	L	R Female	L
Present study (2016)	Nigerian	150.59+14.37	154.92+983	137.92+8.76	142.44+16.18
Udoaka & Nwokediuko (2013)	Nigerians	-	152.80	-	145.0
Wisnuyotin et al., (2014)	-	147.77+9.99	149.25+9.64	132.08+6.92	133.30+8.32

**Table 5:** Comparison of Clavicular length variation in different Races

Author	Year	Population	Length of clavicle Clavicle (mm)	
			Right	Left
Cook et al.,	2012	Scot land	148.3	151.4
Gopalakrishna et al.,	2015	Indian	141.96	143.65
Parsons F.G	1916	English	145	146.50
Singh S	1968	USA	142.54	144.10
Trupti, K.B et al.,	2014	Maharashtra (Indian)	137.78	138.76
Ominde et al.,	2015	Kenyan	146.8	150.4
Chavda et al.,	2013	Gujarati (Indian)	142.28	145.14
Kamdi et al.,	2014	Telangana region	138.71	137.83
Haque M.K et al.,	2011	Nepalese	143.21	145.53
Alcina, et al.,	2015	Spanish	155.12	157.02
Present study	2016	Nigerian	144.26	148.68

## DISCUSSION

There has been a dearth of scholarly work on the radiographic measurement of clavicular parameters for the Nigerian population. This study is intended to fill this gap by providing radiologic measurements for the Nigerian population. The result so obtained is compared with those from other studies. In the present study the mean value for male left clavicle is 154.92mm while that of female is 142.44mm. This agrees with the findings of Udoaka and Nwokediuko (2013)<sup>13</sup> and Wisanuyotin et al., (2014).<sup>14</sup>

The mean length of the right clavicles for both male and female in the present study which are 150.54mm and 137.92mm agrees with the findings of Wisanuyotin et al.<sup>14</sup>

The present study also showed the mean length of the left clavicle to be longer than that of the right for both sexes, this agrees with the result of Wisanuyotin et al.<sup>14</sup> The study observed that male clavicles were generally longer than female clavicles. This is also confirmed by the studies of Wisanuyotin et al (2014), Udoaka Nwokediuko (2013).<sup>13, 14</sup> The difference between the male and female clavicle in the present study is also statistically significant for sex determination with  $P < 0.001$ .

Table 5: illustrate the comparison of interracial variation in the mean length, from the table it could be deduced that the length varied in different races. This variation in the length was obvious in previous studies and is in accordance with the findings in the present study. The mean length of clavicle for Total Population in the present study is 144.26mm on the right side and 148.68mm on the left side. In the present study the mean length of the left clavicles were longer than that of the right with a mean difference of 4.42mm which is statistically significant with  $P < 0.001$ . The mean length of the clavicle in this study for both right and left side compared to studies from other population showed marked racial variations. For the right clavicle the mean length is (144.26mm) in the present study which is similar to the findings of Parson (145mm) for English population,<sup>9</sup> Haque et al., (143.21mm) for Nepalese population,<sup>16</sup> The value in the present study for the right clavicle was higher than that of Kamdi et al., (138.71mm)<sup>15</sup> Telangana region India. Chavda et al., (142.28mm)<sup>3</sup> India, Trupti et al., (137.78mm)<sup>12</sup> for Maharashtra, India, Singh (142.54mm)<sup>10</sup> for USA white population and GopalaKrishna et al., (141.96mm)<sup>5</sup> for Kerala, India. The values obtained by Alcina et al., (155.12mm)<sup>17</sup> for Spanish population, Cook et al., (148.30mm)<sup>4</sup> for the Scottish population and Ominde et al., (146.8mm)<sup>8</sup> for the Kenyan population were slightly than the results from the present study.

For the left clavicle the mean values obtained in the present study (148.68mm) is similar to the values obtained by Ominde et al., (150.4mm)<sup>8</sup> Parson

(146,50mm)<sup>9</sup> Cook et al., (151.4mm).<sup>4</sup> The values obtained in the present study were found to be higher than that obtained in most studies carried out in the Indian population, GopalaKrishna et al., (143.65mm)<sup>5</sup> Trupti et al., (138.76mm)<sup>12</sup> Chavda et al., (145.14mm)<sup>3</sup> Haque et al (145.53)<sup>16</sup> Kamdi et al., (137.83)<sup>15</sup> and Singh (144.10). Studies by Alcina et al on Spanish Whites (157.02) were found to be higher than the values obtained in the present study for the left clavicles. This study as in previous ones has clearly demonstrated racial variations in clavicular lengths among various populations. Olivier working on the French population revealed that there were variations in the length of clavicles even in closely related groups. The observed variations could be attributed to genetic, racial, hormonal, body stature and physical activities.

## Application

The clavicle has been found to fracture easily at the junction between the lateral and intermediate thirds therefore proper study of the length of clavicle and its osteometry is necessary for surgical intervention. In depth knowledge of clavicular length variations will aid in the application of specific devices for clavicular fixation and clavicular prosthesis. It will also promote the development of cutting edge techniques for designing screws, nails, plates for immobilization of clavicular fractures. Extensive evaluation of the clavicular length will reduce clavicular incompatibility of implants and also minimize post operative complications and failure rates.<sup>6</sup> Forensic scientists and anthropologists have found the medial end of the clavicle very useful in age and sex determination.

## CONCLUSION

Variations in clavicular length are evident in different population or races. A sound knowledge of clavicular osteometry is required for surgical intervention and forensic uses. A proper understanding of clavicular length variations is necessary in the design and development of clavicular implant materials and other accessories used by orthopedic surgeons.

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