

Length And Curves Of The Clavicle In Northwest Indians

Kaur, H., Harjeet, Sahni, D., Jit, I.

Department of Anatomy, Postgraduate Institute of Medical Education and Research, Chandigarh INDIA.

Abstract. Length of paired clavicles of northwest Indians of Chandigarh zone was measured in 748 male and 252 female adults (18 to 90 years), 45 male and 30 female children and adolescents (1½ to 17 years), 13 male and 12 female newborns (> 300 mm CR length) and 28 male and 24 female fetuses (32 to 299 mm CR length). In children and adults, the left bone was longer than the right. In fetuses and newborns either of the bone could be longer or the two bones could be of equal length. In adults the sexual difference in the mean length of the clavicle of the two sides was statistically highly significant in all age groups. In adults significant correlation existed in the clavicular length with supine body length, body weight, body surface area and age. The medial and lateral angles of the bone were measured in 113 male and 52 female adults of various age groups. The sum of the two angles, which indicated the total curvature of the bone, showed a statistically significant side and sexual differences in all age groups. With the use of right hand in children the right bone became more curved than the left leading to its straight length (side to side) becoming shorter than that of the left side.

Key words : Clavicle, clavicular length, bones, clavicular angles.

Introduction :

The human clavicle is described as a long bone (*Trotter and Peterson 1953*). It has a shaft and two ends. The right sided long bones of the limbs are usually longer than those of the left side. *Jit and Singh (1966)* showed that the right clavicle was heavier and its mid circumference was greater than those of the left clavicle. *Parsons (1916) & Oliver (1951)*, however found that length of left clavicle was usually greater than that of the right,

Similar observations were recorded by *Jit and Singh (1956, 1966)*. The reason for the same is not understood. No attention has been paid to the curves of the clavicle whether they, in any way, were responsible for a shorter right bone. The present paper attempts to solve this problem on the basis of extensive available material studied in the department.

Material And Methods :

Material for the present study consisted of paired clavicles obtained from cadavers on which medicolegal postmortems had been performed by the fourth author. Before commencing dissection of the cadaver, the age, sex, supine body length and weight were noted and surface area calculated. It was not known if any subject was left handed. The clavicles of the newborns were provided by the Pathology Department of this Institute. Fetuses were a collection of the fourth author in the anatomy museum of the department. The length of the

clavicle was measured in 748 male and 252 female adults (18 to 90 years), 45 male and 30 female children and adolescents (1½ to 17 years), 13 male and 12 female newborns (> 300 mm CR length) and 28 male and 24 female fetuses (32 to 299 mm CR length). The angles (curves) of the bone were measured in 113 male and 52 female adults (18-75 years.) The bones were macerated, cleaned and dried. Care was taken that the epiphysis of the bone, if not fused did not get separated. The length of the bone which, was the straight maximum distance between the two ends was measured with the help of a Vernier caliper (Mitutoya). In case of the embryos and small fetuses the length of the bone was taken with the help of a dissecting microscope having an eye-piece with a micrometer scale. To measure the curves of the bone, the method described by *Parsons (1916)* was followed. The bone was placed on a lump of plasticine in such a position that its anterior and posterior borders were in the same horizontal plane. Tracing of the contour of the bone, as seen from above, was obtained on a sheet of paper with the help of a diagraph (fig.1). The same orientation was kept in all the bones. The midpoints at the sternal and acromial ends were obtained on the contour of the clavicle and were marked as points 'a' and 'b' and were joined by a straight line; the central axis of the bone was drawn as a curved line, midway between the anterior and posterior borders throughout the length of the clavicle. This curved line had two

convexities, the medial two-thirds was convex anteriorly while the lateral one-third was convex posteriorly. The deepest points on the two curves of the bones where the convexities were the maximum, were marked as points 'c' and 'd' which were joined by a straight line. Finally these points were joined with midpoints 'a' and 'b' at the corresponding ends with lines c a and d b, thus two angles were formed: an inner or medial angle a c d which gave the curvature of medial two-thirds, and an outer or lateral angle c d b which indicated the curvature of the lateral one-third. These angles were measured with the help of a protractor. The sum of the two angles constituted the total curvature of the bone. In case of fetuses and newborns, photographs of the clavicles were taken by placing the bone in its normal anatomical position and which were view and angles measured as in case of adults.

Observations

A. Length of the clavicle in adults

Table 1 gives the average length of adult clavicle in various age groups. Sexual differences of right and left bones are also given.

Males

As seen from this Table the mean length of the clavicle on the right side was 143.37 ± 8.93 mm in the age group of 18-20 years which increased to 150.48 ± 8.38 mm in the age group of 26-30 years after which it got stabilized till the age group of 51-60 years when it was 149.76 ± 7.12 mm. The mean length of the left clavicle in the age group of 18-20 years was 145.83 ± 8.20 mm which increased to 152.32 ± 7.94 mm in the age group of 26-30 years, when it became almost stable till the age group of 51-60 years when it was 151.70 ± 8.89 mm. Thus the length of clavicle increased by 7.11 mm on the right side and 6.49 mm on the left side during the period of 18 to 30 years. In the last age group of > 61, it decreased to 147.38 ± 10.74 mm on the right side and 150.07 ± 9.76 mm on the left side. The mean length of the clavicle in the entire age group of 18-90 years was found to be 149.40 ± 8.91 mm on the right side and 151.14 ± 8.72 mm on the left side. However, the side differences in the length of the clavicle were found to be statistically insignificant ($p > 0.05$) in all age groups.

Table 1 : Length of clavicle (in mm) in adults of various age groups

Age group (years)	No. of subjects		Males		Females	
	
	M	F	Right (Mean with SD)	Left (Mean with SD)	Right (Mean with SD)	Left (Mean with SD)
18-20	60	33	143.37±8.93	145.83±8.20	132.03±8.18	134.18±7.73
21-25	154	60	149.92±9.72	151.92±9.64	137.82±9.12	138.97±9.02
26-30	117	42	150.48±8.38	152.32±7.94	137.65±8.78	138.90±8.83
31-35	101	24	150.48±9.65	152.31±9.11	137.71±11.86	138.62±10.92
36-40	74	20	149.21±7.09	151.12±7.24	137.60±8.63	138.50±9.58
41-45	61	18	149.63±8.64	151.05±8.16	136.89±6.92	138.17±7.61
46-50	60	20	150.29±7.70	152.10±8.00	136.25±10.29	137.65±9.72
51-60	81	17	149.76±7.12	151.70±8.89	136.36±10.43	137.01±11.02
61-90	40	18	147.38±10.74	150.07±9.76	134.57±12.02	135.04±11.63
18-90	748	252	149.40±8.91	151.14±8.72	134.53±9.68	136.21±9.64

* Sexual difference in all groups & on both sides were statistically highly significant. ($p < 0.001$)

Females

In females mean length of the clavicle was 132.03 ± 8.18 mm on the right side in the age group of 18-20 years, which increased to 137.82 ± 9.12 mm in the next age group of 21-25 years, after which it was almost stable, till the age of 51-60 years when it was 136.36 ± 10.43 mm. The length of the clavicle on the left side was 134.18 ± 7.73 mm in the age group of 18-20 years which increased to 138.97 ± 9.02 mm in the next age group of 21-25 years, after which it was stationary with very small difference till the age of 51-60 years when it was 137.01 ± 11.02 mm. Thus the length of right clavicle increased by 5.79 mm and left by 4.79 mm during the period of 18 to 25 years. In the last age group of 61 years and above, it decreased to 134.57 ± 12.02 mm on the right and 135.04 ± 11.63 mm on the left side. Mean length of the clavicle in the entire age group 18-90 years was 134.53 ± 9.68 mm on the right side and 136.21 ± 9.64 mm on the left side. Side differences in the length of the clavicles in all age groups were statistically insignificant ($p > 0.05$).

Sexual differences

The difference in the mean length of the clavicles in males and females on the two sides was statistically highly significant in all age groups ($p < 0.001$).

Correlation of clavicular length with supine body length, body weight, body surface area and age (Tables 2 & 3) :

In adults a significant correlation existed in both sexes between the length of clavicle and : (1) supine body length, (2) body weight, (3) body surface area and (4) age.

Table 2 : Correlation of clavicular length with supine body length, body weight, body surface area and age in males.

	t-value		Level of significance	
	Right	Left	Right	Left
1. Supine body length	0.4643	0.4730	1%	1%
2. Body Weight	0.2960	0.2690	1%	1%
3. Body Surface area	0.3874	0.3952	1%	1%
4. Age	0.2872	0.2973	1%	1%

Length of the clavicle in children, newborns and fetuses in the two sexes is given in Tables 4-8.

Table 3 : Correlation of clavicular length with supine body length, body weight, body surface area and age in females

	t-value		Level of significance	
	Right	Left	Right	Left
1. Supine body length	0.3984	0.4160	1%	1%
2. Body Weight	0.2081	0.2043	1%	1%
3. Body Surface area	0.3013	0.3057	1%	1%
4. Age	0.1989	0.1895	1%	1%

Children (Table 4)

The length of the right clavicle which was 74.33 ± 8.49 mm in males and 75.57 ± 9.85 mm in females in the age group of 1-5 years increased to

Table 4 : Length of the clavicle (in mm) in children

Age groups (years)	Sex	n	Right			Left		
				
			Mean	±	SD	Mean	±	SD
1-5	M	9	74.33	±	8.49	74.89	±	7.91
	F	7	75.57	±	9.85	76.71	±	9.32
6-10	M	11	90.82	±	6.13	92.27	±	7.03
	F	3	95.33	±	10.07	97.00	±	12.29
11-15	M	19	113.21	±	11.01	114.53	±	10.66
	F	9	116.25	±	4.20	118.53	±	6.40
16-17	M	6	132.00	±	5.90	135.67	±	7.00
	F	11	129.60	±	6.40	132.20	±	5.84
1-17	M	45	102.47	±	20.97	103.98	±	21.61
	F	30	106.57	±	4.50	107.35	±	21.93

132.00 ± 5.90 mm and 129.60 ± 6.40 mm respectively in the age group of 16-17 years. Similarly, the left bone which was 74.89 ± 7.91 mm in males and 76.71 ± 9.32 mm in females in the first age group increased to 135.67 ± 7.00 mm in males and 132.20 ± 5.84 mm in females in the age group of 16-17 years. Although the length of the left clavicle in all age groups of both sexes appeared to be *marginally* more than that to the right, the differences were statistically insignificant ($p > 0.05$). Sexual differences were also statistically insignificant ($p > 0.05$).

Newborns and Fetuses (Tables 5-8)

The length of the clavicle increased steadily with increasing CR length. Observations recorded in

Table 5 : Length of the clavicle (in mm) in male newborns

CR length (mm)	n	Length of clavicle	
		Right	Left
301-310	2	38.2	37.5
311-320	1	38.5	37.5
321-330	3	39.8	38.8
331-340	1	41.0	39.0
341-350	2	42.7	42.0
351-360	3	45.0	45.5
361-370	1	47.0	47.0

Table 6 : Length of the clavicle (in mm) in female newborns

CR length (mm)	n	Length of clavicle	
		Right	Left
301-310	3	37.8	37.3
321-330	2	38.7	39.0
331-340	1	39.0	40.0
341-350	1	40.0	41.0
351-360	2	42.0	41.5
361-370	3	44.3	44.3

Table 7 : Length of the clavicle (in mm) in male fetuses

CR Length (mm)	n	Length of Clavicle	
		Right	Left
30-40	1	5.0	5.0
41-50	2	8.7	9.2
51-60	2	10.5	10.2
61-70	2	11.0	11.0
71-80	1	11.5	12.0
81-90	1	12.0	14.0
91-100	1	13.0	14.0
101-110	1	14.0	14.0
111-120	1	15.0	15.0
121-130	1	15.0	16.0
131-140	1	16.0	16.0
141-150	1	19.0	20.0
151-170	1	20.0	20.0
180-190	1	21.0	21.0
200-210	1	23.0	25.0
230-240	1	27.0	28.0
241-250	1	29.0	29.0
251-260	2	31.4	30.9
261-270	2	32.3	32.6
271-280	2	34.0	33.5
281-290	1	35.4	35.4
291-299	1	37.0	37.0

Table 8 : Length of the clavicle (in mm) in female fetuses

CR Length (mm)	n	Length of clavicle	
		Right	Left
70-80	1	11.0	12.0
81-90	1	12.0	12.0
91-100	2	13.5	14.0
101-110	1	14.0	15.5
111-120	1	14.0	16.0
121-130	1	15.0	16.0
131-140	2	17.0	16.5
141-150	1	18.0	18.0
151-160	1	20.0	20.0
171-180	1	20.0	21.0
191-200	1	25.0	23.0
221-230	1	27.0	26.0
241-250	1	29.0	30.0
251-260	3	30.4	30.0
261-270	2	31.0	32.0
271-280	2	33.3	33.7
281-290	1	34.0	36.0
291-299	1	36.0	37.0

adults that the left clavicle was usually *marginally* longer than the right are not applicable to fetuses and newborns of both sexes. The left bone may be longer than the right or *vice versa* ; the two bones may even be of equal length. Side and sexual difference in each age group were statistically insignificant ($p > 0.05$).

(B) Angles of the clavicle

Adults (18-75 years)

Medial angle

Medial angle of the clavicle in various age groups is given in Table 9.

Males :

The angle was $152.17^\circ \pm 2.20^\circ$ on the right side and $152.50^\circ \pm 2.15^\circ$ on the left side in the age group of 18-20 years. It remained almost stationary in the subsequent age groups till the age of 60 years after which it decreased to $147.56^\circ \pm 1.01^\circ$ on the right side and $148.64^\circ \pm 1.21^\circ$ on the left side. No

Table 9 : Medial angle (in degrees) in various age groups in adults (18-75 years)

Age groups (years)	No. of subjects		Males		Females	
			Right	Left	Right	Left
	M	F	(Mean with SD)	(Mean with SD)	(Mean with SD)	(Mean with SD)
18-20	12	7	152.17±2.20	152.50±2.15	155.29±1.84	154.30±1.62
21-30	35	13	150.82±5.79	151.22±4.51	154.82±3.56	154.31±3.77
31-40	30	9	151.53±4.50	150.89±4.85	155.01±5.33	154.67±5.03
41-50	16	10	152.50±3.09	152.35±2.31	154.82±2.40	154.28±1.90
51-60	12	7	151.02±2.96	152.08±2.32	153.80±1.70	154.08±1.35
61-75	8	6	147.56±1.01	148.64±1.21	149.00±1.04	149.93±0.93
18-75	113	52	150.76±5.47	150.94±4.71	152.61±5.62	152.35±5.78

noticeable side differences were present.

Females :

The medial angle which was $155.29^\circ \pm 1.84^\circ$ on the right side and $154.30^\circ \pm 1.62^\circ$ on the left side in the first age group of 18-20 years, remained static till the age of 60 years after which it decreased to $149.00^\circ \pm 1.04^\circ$ on the right and $149.93^\circ \pm 0.93^\circ$ on the left side. No side differences were seen.

Sexual differences :

Sexual differences in the medial angles of the two sides were statistically significant in all age groups ($p < 0.01$ or 0.05).

Lateral angle

Lateral angle in various age groups is given in Table 10.

Males :

The mean lateral angle in the males which was

Table 10 : Lateral angle (in degrees) in various age groups in adults (18-75 years)

Age groups (years)	No. of subjects		Males		Females	
			Right	Left	Right	Left
	M	F	(Mean with SD)	(Mean with SD)	(Mean with SD)	(Mean with SD)
18-20	12	7	142.92±7.29	146.58±6.49	145.42±7.90	151.28±8.50
21-30	35	13	143.50±9.33	148.24±8.27	147.80±9.90	152.84±8.27
31-40	30	9	142.93±9.65	150.87±8.62	145.22±5.59	152.22±7.81
41-50	16	10	144.07±8.01	147.72±8.79	146.00±8.50	150.51±7.50
51-60	12	7	143.85±9.27	150.16±8.89	145.69±9.51	150.00±7.30
61-75	8	6	143.29±9.98	148.02±7.75	144.00±8.67	148.05±6.79
18-75	113	52	143.27±10.49	148.20±8.81	144.65±10.06	148.73±9.30

$142.92^\circ \pm 7.29^\circ$ on the right side in the age group of 18-20 years, remained almost stationary in the higher age group. On the left side the angle which was $146.58^\circ \pm 6.49^\circ$ in the first age group fluctuated slightly in the subsequent age groups. In the total

sample (18-75 years) the angle of the right bone was $143.27^\circ \pm 10.49^\circ$ and that of the left bone $148.20^\circ \pm 8.81^\circ$ ($p < 0.001$). As the angle of the left bone was greater than that of the right it showed that the lateral one-third of the bone on the left side was longer than the right.

Females :

In the age group of 18-20 years, the angle was $145.42^\circ \pm 7.90^\circ$ on the right side and $151.28^\circ \pm 8.50^\circ$ on the left side. The angle on both sides fluctuated slightly, the maximum angle was $147.80^\circ \pm 9.90^\circ$ on the right and $152.84^\circ \pm 8.27^\circ$ on the left side in the age group of 21-30 years. In the entire sample of 18-75 years, the angle was $144.65^\circ \pm 10.06^\circ$ on the right side and $148.73^\circ \pm 9.30^\circ$ on the left side ($p < 0.05$). It again showed that in females also the part of the bone forming the lateral angle was longer on the left side than on the right.

Sexual difference :

Sexual differences in the mean of the lateral angles on both sides in all age groups were statistically insignificant ($p > 0.05$).

Sum of the two angles in the clavicle (Total curvature)

The mean of the sum of the two angles in various age groups in the two sexes is given in Table 11.

Table 11 : Sum of the two angles (in degrees) in various age groups in adults (18-75 years)

Age groups (years)	No. of subjects		Males		Females	
			Right	Left	Right	Left
	M	F	(Mean with SD)	(Mean with SD)	(Mean with SD)	(Mean with SD)
18-20	12	7	294.05±6.12	299.68±7.21	300.70±4.70	305.87±4.18
21-30	35	13	293.37±6.54	299.16±6.97	299.00±7.91	304.92±6.28
31-40	30	9	294.08±4.36	300.76±4.56	298.33±3.52	304.33±4.96
41-50	16	10	295.57±4.60	300.09±4.93	298.83±3.27	304.81±4.36
51-60	12	7	295.00±4.62	300.76±4.42	299.09±3.28	303.86±2.85
61-75	8	6	292.77±2.60	297.70±1.69	295.74±1.15	299.57±1.29
18-75	113	52	293.08±10.90	298.04±9.57	297.06±10.61	301.31±8.95

Males :

The mean of the sum of the two angles in the age group of 18-20 years was $294.05^\circ \pm 6.12^\circ$ on the right side and $299.68^\circ \pm 7.21^\circ$ on the left which

remained almost stationary with small variations till the age of 60 years. Thereafter, in the age group of 61-75 years, it decreased to $292.77^\circ \pm 2.68^\circ$ on the right and $297.70^\circ \pm 1.69^\circ$ on the left side. The mean sum of the two clavicular angles in the entire age group of 18-75 years was $293.08^\circ \pm 10.90^\circ$ on the right side and $298.04^\circ \pm 9.57^\circ$ on the left side. The sum of the two angles was statistically more on the left than on the right side in all age groups including the total sample ($p < 0.05$).

Females :

The mean of sum of two angles was $300.70^\circ \pm 4.70^\circ$ on the right and $305.87^\circ \pm 4.18^\circ$ on the left side in the age group of 18-20 years. It was almost stationary with small variations till the age of 60 years, thereafter, it decreased to $295.74^\circ \pm 1.15^\circ$ on the right and $299.57^\circ \pm 1.29^\circ$ on the left side. In the entire age group it was $297.06^\circ \pm 10.61^\circ$ on the right side and $301.31^\circ \pm 8.95^\circ$ on the left. It is, therefore, noted that the sum of the two angles was more on the left than on the right side. The side difference in the sum of the two angles was statistically

significant ($p < 0.05$) in all age groups including the total sample.

Sexual difference :

The sexual differences in the means of the sum of the angles on the two sides in various age groups including the total sample was statistically significant ($p < 0.05$).

Discussion :

Measurements and sexual differences in clavicles of western countries have been studied by *Parsons (1916)*, *Terry (1932)*, *Olivier (1951, 56)* and *Singh (1969)*. In India, the subject has been studied extensively by *Jit and his associates (1956, 1966, 1976, 1983)*.

Length of the clavicle

Racial differences :

The length of the clavicle as recorded by different workers in western countries and as found by workers in India are given in Tables 12 and 13.

Table 12 : Mean length of clavicle in the two sexes in western population as compared to the present observations in northwest Indians

Population	No. of cases examined		Mean length (in mm)			
			Males		Females	
	M	F	Right	Left	Right	Left
English (Parsons, 1916)	50	50	152	154	138	139
U. S. A. Whites (Terry, 1932)	50	—	152.90±0.88	154.10±0.91	—	—
U. S. A. Whites (Singh, 1972)		230	151.40	153.37	133.68	134.84
U. S. A. Negroes (Terry, 1932)	50	50	153.30±0.83	155.86±0.92	140.98±0.76	141.78±0.03
U. S. A. Negroes (Singh, 1972)		80	155.72	157.32	137.60	140.80
French (Olivier, 1951)	110	60	154.20	155.00	137.90	138.70
(Present workers, 2002)	748	252	149.40±8.91	151.14±8.72	134.53±9.68	136.21±9.64

Table 13 : Mean values of length of clavicles in the two sexes in Indians in different zones

Different zones	No. of cases		Mean length (in mm)			
			Males		Females	
	M	F	Right	Left	Right	Left
Amritsar zone (Jit and Singh, 1966)	236	112	145.58±8.60	147.59±9.25	130.36±9.11	129.80±1.77
Varanasi zone (Singh and Gangrade, 1968b)	97		141.49±8.22	144.18±8.01	125.78±7.50	127.77±8.09
Chandigarh zone (Jit and Sahni, 1983)	280	80	148.00±8.60	149.80±8.40	132.40±8.40	134.00±8.10
Chandigarh zone (Present findings)	748	252	149.40±8.91	151.14±8.72	134.53±9.68	136.21±9.64

On measuring 100 pairs of English clavicles (50 males and 50 females) of known age and sex, *Parsons (1916)* observed that the left clavicle was longer than the right in 54% instances; in 34% cases the right was longer than the left and in the remaining 12% specimens both clavicles were of equal length. *Terry (1932)* measured the length of 100 pairs of clavicles from American Negroes and 50 pairs from American Whites, the sex and approximate age of which were known. He noted that in the male and female American Negroes and in male American Whites the left bone was longer than the right, but statistically the side differences were significant only in the American Negro males. He also observed that the clavicles of American Negroes were longer than those of the American Whites. *Olivier (1951)* studied 110 male and 60 female adult clavicles of French people and observed that in an individual the left clavicle was usually longer than the right. He made a comparative study of the work of other authors, regarding the average length of the clavicle in large number of racial groups; the average length of the clavicle was 118.2 mm in the inhabitants of Andaman island but was 158 mm in American Indians. He pointed out that length of clavicle was

not the same even in closely related racial groups, the average length of the bone was different in different races. He further observed that the length of the clavicle in Tyroleans was much smaller than that of the people of Switzerland, but was similar to that of the Hottentots, Javanese and Australians although the latter were not related ethnically to Tyroleans; very widely separated and unrelated races might have similar length e.g. the Finlanders and Japanese. *Singh (1969)* measured 310 adult clavicles out of which 230 were of the American Whites and 80 of American Negroes. The bones were selected at random from Todd's collection preserved at the Western Reserve University School of Medicine, Cleveland, Ohio. He subjected his data to a statistical analysis and confirmed the observations of *Terry (1932)* regarding the length of clavicle. *Jit and Singh (1966)* recorded the length of the paired clavicles of 80 male and 40 female Punjabees, and found that left clavicle was longer than the right. They recorded that in 66.3% pairs of male clavicles the left was longer than the right by 0.5 to 13.0 mm, in 24.4% instances the right bone was longer by 0.5 to 8.0 mm and in the remaining 9.3% instances both the bones were of equal length. According to them in female clavicles the left bone

was longer in 50% specimens by 1.0 mm to 8.0 mm, the right was longer in 32.5% specimens by 0.5 to 6.0 mm and they were of equal in length in the remaining 11.5% specimens.

They also observed that the Punjabee male clavicles had about the same length as that of the Chinese although the two belonged to different races; the clavicular length of female Punjabees was similar to that of the Tyroleans and Portuguese females. *Singh and Gangrade (1968a)* measured the length of 150 clavicles out of which 80 were from Varanasi zone and 70 from Amritsar zone. They observed that the clavicles of Varanasi zone were shorter in length than those of the Amritsar zone. They also supported the findings of various workers that the left clavicle was usually longer than the right. In another sample of 200 clavicles (97 pairs) of Varanasi zone. *Singh and Gangrade (1968b)* measured the length of the bone and supported their previous observations. *Jit and Sahni (1983)* noted the length of 260 pairs of male and 80 pairs of female clavicles of North Indian adults (Chandigarh zone). They found the left clavicle to be longer than the right in 60% instances and both clavicles were of equal length in 30% instances. Further according to them the length of the clavicles of Chandigarh zone was greater as compared to that of Amritsar zone but was smaller than that of American Whites.

In the present material it has been observed that the length of left clavicle was longer than the right in the males in 61.6% by 1.0 mm to 18.0 mm; the right was longer in 24.7% instances by 1.0 to 9.0 mm and in 13.6% cases both the clavicles were of equal length; in case of female bones the left clavicle was longer in 61.5% instances by 1.0 mm to 13.0 mm, the right in 22.6% cases by 1.0 mm to 8.0 mm and in 15.8% instances both the clavicles were of equal length. As seen in Table 1, the mean length of the male clavicle in the age group of 18-75 years was 149.40 ± 8.91 mm on the right side and 151.14 ± 8.72 mm on the left side, while in the females the mean length of the right bone was 134.53 ± 9.68 mm and the left was 136.21 ± 9.64 mm. Therefore, the present observations showed that the male clavicles of Chandigarh zone have the same clavicular length as that of the ancient Norwegians,

and the female clavicles have length as those of the ancient Belgians and North American Whites.

It was also noted that in various zones of India the length of the clavicle was different, clavicles of Chandigarh zone were longer than those of Amritsar zone, which in turn were longer than those of Varanasi zone. These differences in lengths of the clavicles in the three zones in India may be due to the fact that the present people of Chandigarh zone are better fed and healthier than those of Amritsar zone. It is also a fact that people from Northwest zone of India are taller than those of Varanasi zone.

Sexual differences (Table 14)

All workers agree that both right and left clavicles of female were shorter (by about 10%) than those of the males ($p < 0.005$).

Table 14 : Proportion of female clavicle to male clavicle in different populations

Defferent zones	No. of sepcimens		Proportion (Female : Male)	
	M	F	Right	Left
English (Parsons, 1916)	50	50	90.8	90.2
U.S.A. Negroes (Terry, 1932)	50	50	91.9	90.9
U.S.A. Negroes (Singh, 1972)	80		88.3	89.5
U.S.A. Whites (Singh, 1972)	230		88.3	87.9
Amritsar zone (Jit and Singh 1966)	236	112	89.5	87.9
Varanasi zone (Singh and Gangrade, 1968b)	97	—	88.9	88.6
Chandigarh zone (Jit and Sahni. 1983)	280	80	89.4	89.4
Chandigarh zone (Present findings)	748	252	90.0	90.1

Curves of the clavicles (Table 15)

Medial angle :

Racial differences

Observation made by *Parsons (1916)* revealed that the medial angle of English clavicle on both sides was 153° in males and 155° in females. However, he did not subject his observations to a statistical analysis. *Terry (1932)* found that the mean medial angle in American Negro males was 153.52° on the right and 151.58° on the left side, while in the females it was 151.12° on the right and 153.62° on the left side. He also observed that there were no racial differences in the medial angle of the male

American Negroes and American White, but side differences in the American Whites were statistically significant. In French clavicles, *Olivier (1951)* observed the medial angle to be 150.2° on the right and 151.4° on the left side in the males and 151.0° in the females on the right side. He also found that the male right clavicles had a greater medial angle in 40% bones, left in 16% instances, and both had equal angles in 44% clavicles. In the present material the mean medial angle in the males was 150.76° on the right and 150.94° on the left side, while in the females it was 152.61° on right and 152.85° on the left side. The side differences in the mean medial angle on the two sides were found to be statistically insignificant; the medial angle of northwest Indians was almost the same as that of the French clavicles but was smaller than that of the American Negroes, American whites and English. Thus, it was noted that the clavicles of the French and the northwest Indians were more curved in their medial two-thirds than the clavicles of the American Negroes, American whites and the English.

Sexual differences :

Parsons (1961) noted that the medial angle on both sides was greater in female clavicles than in males by 2° . In the American Negroes, *Terry (1932)* found this difference to be 2.4° on the right and 2.0° on the left. He also noted this difference was statistically significant. He recorded that the medial angle was greater on right side in males, while it was greater on left side in females. *Olivier (1951)* did not find any difference in the mean medial angle in the two sexes. The present observations show that sexual difference in the mean medial angle was 1.85° on the right and 1.91° on the left side. This difference was found to be statistically significant ($p < 0.05$). It was also observed that the medial angle was greater in the females than in the males, thus the medial two-thirds of the male bones was more curved than the female bones.

Lateral angle :

Side and racial differences :

Parsons (1961) recorded the mean lateral angle of the English male clavicle as 148° on both sides; while in the females it was 150° on the right

and 151° on the left side. On measuring the mean lateral angle of the American Negroes and American Whites, *Terry (1932)* observed that in the American Negroes and American Whites, the lateral angle was greater on the left side, but the side differences were statistically significant only in the male American Negroes and American Whites; they were insignificant in female American Negroes; racial differences in the mean lateral angle of American Negroes and American Whites were insignificant. *Olivier (1951)* also noted that in the French clavicles the lateral angle was greater on the left than on the right side. In the present material the mean lateral angle in the male bones was 143.27° on right and 148.20° on the left side, while in the females it was 144.65° on the right and 148.73° , on the left side. The side differences in the mean lateral angle on the two sides were statistically significant. The lateral angle was found to be greater on the left side in both sexes. The right bones were, therefore, more curved than the left bones. The lateral angle of the clavicle as recorded in the present material was greater than that found in the American Negroes, American Whites and French clavicles but was smaller on the right and almost the same on the left as noted in the English clavicles.

Sexual differences :

In the English clavicles *Parsons (1916)* noted the differences between the mean lateral angle of the males and females to be $2^\circ - 3^\circ$, and also found that the lateral angle was greater in the females than in the males. *Terry (1932)* recorded that in the American Negroes this difference was 5.64° on the right and 2.28° on the left side and found this difference to be statistically significant. In the French clavicles *Olivier (1951)* noted the sexual differences in the lateral angle to be 2.5° . He also found that the angle was greater in the females as compared to that in the males. Present observations show that the difference in the mean lateral angle in the two sexes was 1.38° on the right and 0.53° on the left side. This difference was found to be statistically insignificant ($p > 0.05$).

Sum of the two angles :

Racial differences :

Parsons (1916) called the sum of two angles

as 'index of curvature'. He calculated the sum of two angles of the English clavicle and found the mean index as 300° on the right side and 301° on the left side in males, while in females it was 305° on the right and 306° on the left side. He noted the side difference of 1° in both sexes and found that the right bone was more curved than the left in both males and females. He found that the side differences in both sexes were only 1° . According to *Terry (1932)* the sum of the two clavicular angles was greater on the left side than that of the right.

In French clavicles, *Olivier (1951)* noted that the sum of two angles was 292° on the right and 294.4° on the left in the males and also found that the right bone was more curved than the left bone. In the present material the mean sum of angles was 293.08° on right and 298.64° on the left side in the males and 297.06° on right and 301.31° on the left in females. The side difference between the sum of the angles was statistically highly significant ($p < 0.001$) in both sexes. As the sum of angles was greater on the left than on the right side; the right bone was, therefore, more curved than the left. As

seen from the Table 15, the clavicles in the present material were more curved than the clavicles of the English people but were less curved than the clavicles of the French and American Negroes.

Sexual differences :

All the previous workers mentioned above agree that the male bones are more curved than the female bones. In English clavicles *Parsons (1916)* observed that the difference in the mean sum of angles between the males and females was 5° on both right and left side. *Terry (1932)* recorded that this difference was 1.88° on the right and 2.96° on the left side. He found the sexual difference in the mean sum of angles to be statistically significant. In French clavicles *Olivier (1951)* noted the sexual difference in the sum of angles of the right bone to be 4.5° . In the present material the difference between the mean sum of angles of the males and females was 3.98° on the right side and 2.67° on the left side. This sexual difference was found to be statistically significant ($p < 0.05$).

Table 15 : Mean of the medial,lateral angles and sum of two angles in different populations (in degrees)

Population	No. Of specimens		Medial angle				Lateral angle				Sum of two angles			
	M	F	Males		Females		Males		Females		Males		Females	
			Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.
English (Parsons, 1916)	50	50	153.0	153.0	155.0	155.0	148.0	148.0	150.0	151.0	300.0	301.0	305.0	306.0
American Negroes (Terry, 1932)	50	50	153.52	151.58	151.12	153.62	138.42	143.54	144.06	145.82	292.00	294.94	293.88	297.90
American Whites (Terry 1932)	50	—	153.12	151.42	—	—	139.25	142.66	—	—	293.08	293.80	—	—
French (Olivier, 1951)	110	62	150.2	151.4	151.0	—	141.8	143.0	145.0	—	292.0	294.4	296.5	—
Chandigarh zone (present findings)	113	52	150.76	150.94	152.61	152.82	143.27	148.20	144.65	148.73	293.08	298.04	297.06	301.31

Conclusions :

Length of the adult left clavicle is more than that of the right side. This difference was not present in fetuses, newborns and children in which the bone of any side may be longer than that of the other side. With use of right hand, the curve of the right clavicle in adults became greater than that of left side which lead to a shorter right bone as compared to the left. Sexual difference in length, angle and curves of the bone were statistically significant.

References :

1. Jit, I. and Kulkarni, M. (1976) : Times of appearance of fusion of epiphyses at the medial end of clavicles. *Indian Journal of Medical Research*, **64**: 773-782.
2. Jit, I. and Sahni, D. (1983): Sexing the north Indian clavicles. *Journal of Anatomical Society of India*. **32(2)**: 61-72.
3. Jit, I. and Singh, S. (1956): Estimation of stature from clavicles. *Indian Journal of Medical Research*. **44**: 137-155.
4. Jit, I. and Singh, S. (1966): The sexing of the adult clavicles. *Indian Journal of Medical Reserach*. **54**: 551-571.
5. Olivier, G. (1951): Anthropologie de la Clavicule. III, La clavicule due Francis. Bulltins et. *Memories de la Societe. D' Anthropologie* **2**: 121-157.
6. Olivier, G. (1956): Anthropologie de la Clavicule. XIII, Conslusions generals. Bulltins et. *Memories de la Societe. D' Anthropologie*. **7**: 404-447.
7. Parsons, F.G. (1916): On the proportions and characteristics of the modern English clavicle. *Journal of Anatomy* **51**: 71-93.
8. Singh, S. (1969): Sexing of American clavicles. *Journal of Anatomical Society of India*, **18**: 25 (Abstract).
9. Singh, S. and Gangrade, K.C. (1968a): The sexing of adult clavicles-verification and applicability of demarking points. *Journal of Indian Academy of Forensic Sciences*, **7**: 20-30.
10. Singh, S. and Gangrade, K.C. (1968b): The sexing of adult clavicles-demarking points for Varanasi zone. *Journal of Anatomical Society of India*. **17**: 89-100.
11. Terry, R.J. (1932): The clavicle of the American Negro. *American Journal of Physical Anthropology*. **16**: 351-380.
12. Trotter, M. and Peterson, R.R. In Morri's Human Anatomy. B.J. Anson (ed). 12th edn 244 McGraw Hill, New York. p. 244 (1966).

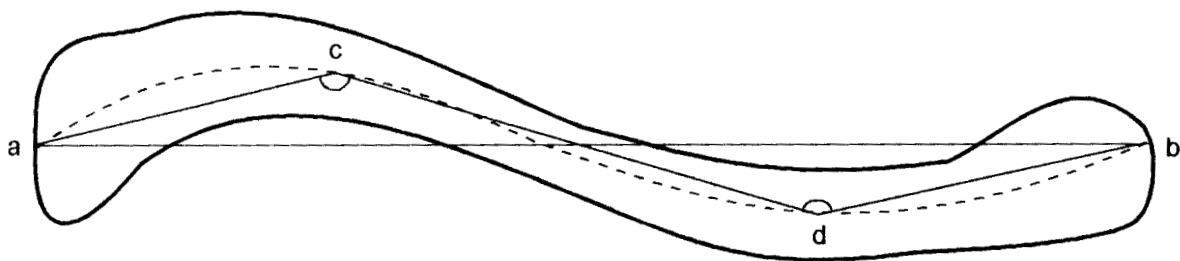


Fig.1: Contour of the right clavicle as seen from above

- a - Midpoint of sternal end
- b - Midpoint of acromial end
- c - Deepest point of medial curvature
- d - Deepest point of lateral curvature
- a c d - Medial angle
- c d b - Lateral angle