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Morphometric Study of the Proximal End of the Adult Human Dried Radii

Abhigyan Satyam[1], Ashish V Radke[2]

Abstract

Introduction: Knowledge of size and shape of proximal end of radius *i.e.* radial head is necessary for creation of anatomically and biomechanically correct radial head prosthesis. This difference in biome-chanics of circular shape and the elliptical shape of radial head must be taken in consideration in design of radial head prosthesis.[2] Further understanding of dimensions of bicipital tuberosity and its angular relationship to radial head is important in pathophysiology of bicepstendon rup-ture as well as to facilitate surgical procedures like reconstruction of biceps tendon, radial head prosthesis and implantation and reconstruction of proximal head trauma.[3] Several studies have been published on anatomy using different technical approaches however, most of these studies were conducted with special focus on parameters relevant to radi-al prosthetic design. The purpose of this study was to explore the complex geometry of the prox-imal radius with regard to fracture implant design.[4] *Methods:* Randomly selected 100 right and 100 left dried radii of Adult Human (20 years and above) of unknown gender were studied. The data obtained was analyzed statistically to find out mean, range, SD, standard error and 95% confidence intervals of observations. Box and whisker's plot are showing the pictorial forms of the observation sat a glance. *Results:* The mean height, anteroposterior and transverse diameter of head, length of radial neck, length of radial tuberosity, Neck shaft angle of radius, circumference at radial tuberosity of radius were 10.39 mm, 20.21 mm, 19.65 mm 11.62 mm, 19.40 mm, 169.29 degree and 4.78 cm respectively.

Keywords: Radial Head; Neck; Angle; Prosthesis.

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Introduction

Restoration of the anatomical situation can only be achieved when the implant is placed in the correct position, even with a perfectly created anatomical prosthesis.[1] Knowledge of size and shape of radial head is necessary for creation of radial head prosthesis that is anatomically and biomechanically correct. The biomechanics of the circular shape and the elliptical shape are different involving an adaptation of the angle between the neck and the radial diaphysis.This difference must be taken in consideration in the design of a radial head Prosthesis.[2] Further understanding of the dimensions of bicipital tuberosity and its angular relationship to radial head is important in pathophysiology of bicepstendon rupture as well as to facilitate surgical procedures like reconstruction of biceps tendon, radial head prosthesis and implantation and reconstruction of proximal head trauma.[3] The proximal radius features a complex anatomy. Several studies have been published on the anatomy using different technical approaches however, most of these studies were conducted with a special focus on parameters relevant to radial prosthetic design. The purpose of this study was to explore the complex geometry of the proximal radius with regard to fracture implant design.[4]

The morphological study of the proximal radius can be used to reconstruct the geometry of the

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injured radial head based on the obtained geometric features of the contra-lateral side.[6] Exact anatomical description of the proximal radius is imperative for the development of radial head prostheses.[7]

Morphometric radius study may also help in anthropometric, forensic, and archaeological investigation for the estimation of the stature of the remains of unknown bodies using regression equations and could serve as the basis of comparison for future studies.[10]

Materials and Methods

Randomly selected 100 right and 100 left dried radii of Adult Human (*20 years* and above) of unknown gender were studied from bone library of MCI recognized medical institutions.The data obtained was analyzed statistically to find out mean, range, D, standard error and 95% confidence intervals of the observations. The Box and Whisker's plot are showing the pictorial forms of the observation sat a glance. The various measurement are taken as described below:

1. Height of radial head: 5, 6, 9, 10, 13, 14.

   - Distance between the radial lips (superior border) to the head neckborder (Fig. 1).

Fig. 1:

2. *Anteroposterior diameter of radial head*: 2, 4, 5, 6, 7, 9, 12, 13, 14.

   - Distance between maximum convexity of its anterior and posteriorends (Fig. 2).

Fig. 2:

3. *Transverse diameter of radial head*: 2, 4, 9, 12, 14.

   - Distance between the maximum convexity of its lateral and medial ends (Fig. 3).

Fig. 3:

4. *Length of radial neck*:1,8,12.

   - Distance between upper margin of head neck border to upper most end of radial tuberosity (Fig. 4).

Fig. 4:

5. *Length of radial tuberosity*: 3, 12, 14.

   - Distance between the upper most and lower most ends of radial tuberosity (Fig. 5).

Fig. 5:

6. *Neck shaft angle*: 1, 2, 3, 8.

   -Angle between long axis of neck and long axis of shaft of radius (Figs. 6 and 7).

Fig. 6:

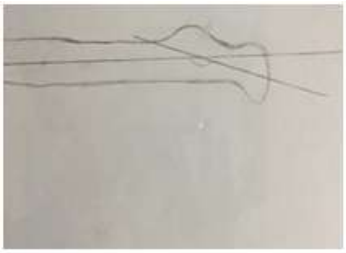


Fig. 7:

7. *Circumference at radial tuberosity of radius*: 10–11.

   - Circumference at maximum convexity of radial tuberosity (Fig. 8) taken at radial tuberosity by the help of suture thread is calculated with measuring scale.

Fig. 8:

Results

The mean, range, SD, standard error and 95% confidence intervals of all parameters for right and left radius shown in tables.

Box and Whisker's plot are showing the pictorial forms of observations of all parameters for right and left radius.

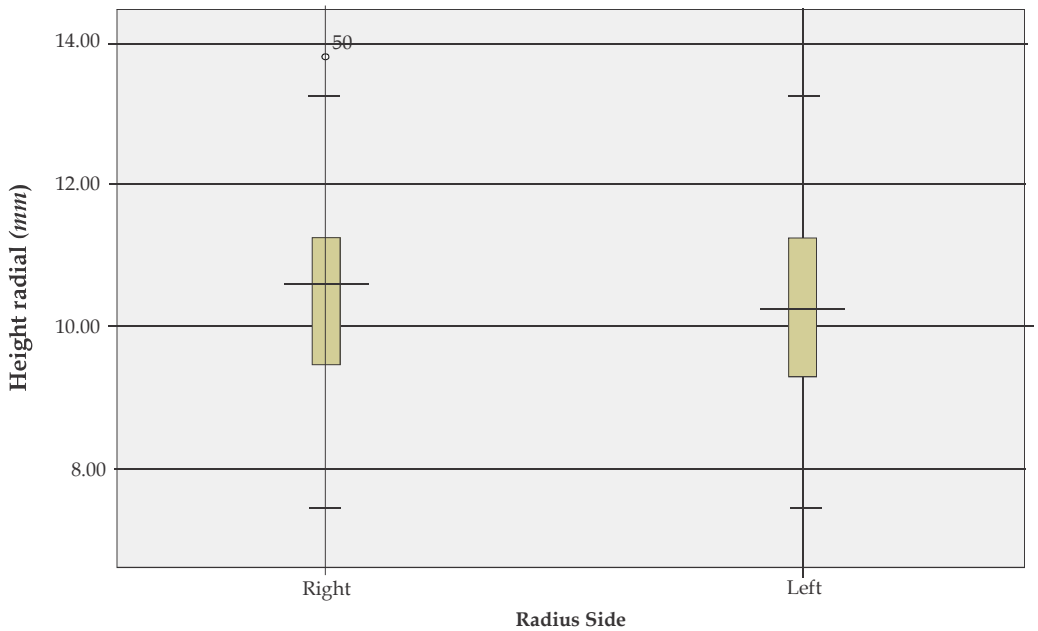
All the results depicted at the end of this article in the tables 1–7 and also in Box and Whisker's plot 1–7.

Table 1: Values of Height of Radial Head *(mm)*.

Height of Radial Head (*mm*)	*N*	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		*Min.*	*Max.*	Normal Range	
					Lower Bound	Upper Bound			*LL*	*UL*
Right	100	10.41	1.19	0.12	10.17	10.65	7.76	13.87	8.07	12.75
Left	100	10.38	1.24	0.12	10.13	10.62	7.48	13.48	7.95	12.81
Total	**200**	**10.39**	**1.21**	**0.09**	**10.22**	**10.56**	**7.48**	**13.87**	**8.01**	**12.77**

***Abbreviation used*:** N-Number; LL-Lower Limit; UL-Upper Limit.

***Box and Whisker's plot* 1**



Box Plot 1: Comparing Median and quartiles values for Height of radial head of right and left sides.

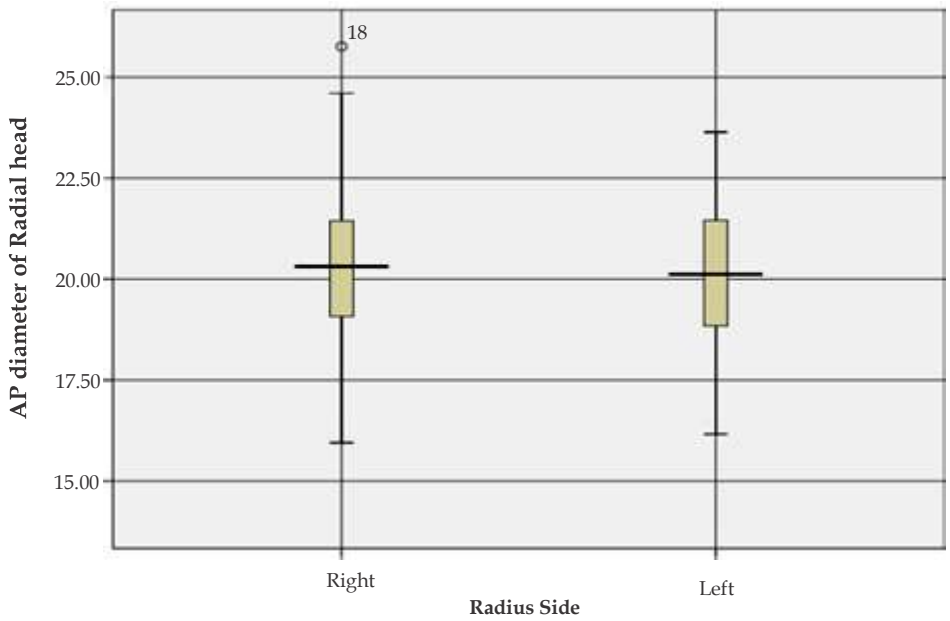
Box Plot 1 shows that the data for height of radial head for right and left radius. It is negatively skewed, where sample number 50 is outlier which is not considered in the study.

Table 2: Values of AP diameter of Radial Head (*mm*).

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.	Normal range	
						Lower Bound	Upper Bound			LL	UL
AP diameter of Radial Head (*mm*)	Right	100	20.32	1.92	0.19	19.94	20.70	15.95	25.76	16.56	24.09
	Left	100	20.09	1.81	0.18	19.73	20.45	16.16	23.64	16.55	23.63
	Total	**200**	**20.21**	**1.86**	**0.13**	**19.95**	**20.47**	**15.95**	**25.76**	**16.55**	**23.86**

Abbreviation used: N-Number; LL-Lower Limit; UL-Upper Limit.w

Box and Whisker's plot 2



Box Plot 2: Comparing Median and quartiles values for anteroposterior diameter of Right and Left Radial Head.

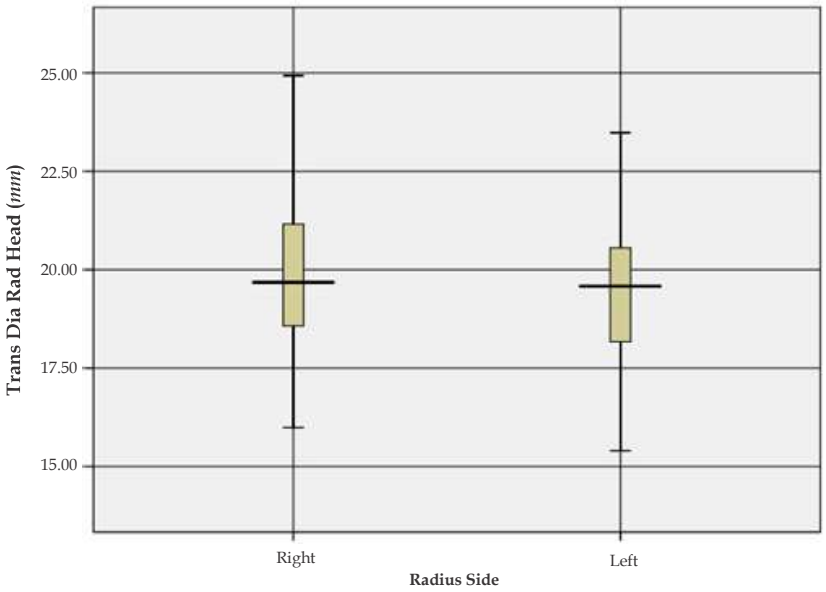
Box Plot 2: shows that the data for AP diameter of radial head of right and left radius. It is positively skewed, where sample 18 is outlier.

Table 3: Values of Transverse Diameter of Radial Head (*mm*).

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		*Min.*	*Max.*	Normal range	
						Lower Bound	Upper Bound			*LL*	*UL*
Trans Dia Rad Head (*mm*)	Right	100	19.85	1.86	0.19	19.48	20.22	15.99	24.93	16.21	23.49
	Left	100	19.45	1.77	0.18	19.10	19.80	15.40	23.48	15.98	22.92
	Total	**200**	**19.65**	**1.82**	**0.13**	19.40	19.90	15.40	24.93	16.08	23.22

Abbreviation used: N-Number; LL-Lower Limi; UL-Upper Limit.

***Box and Whisker's plot* 3**



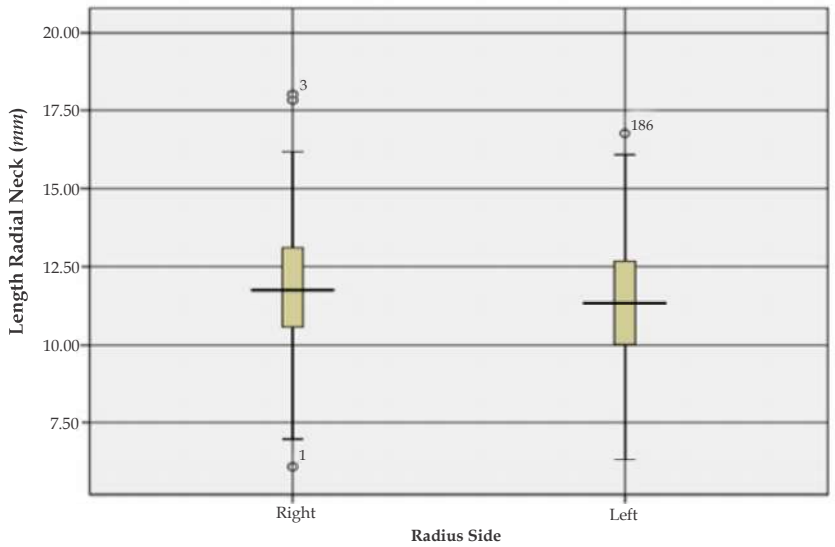
Box Plot 3: Comparing Median and Quartiles values for Transverse diameter of Radial head between Right and Left Sides.

Box Plot 3 shows that the data for transverse diameter of radial head of right and left radius. It is positively skewed.

Table 4: Values of Length Radial Neck (*mm*).

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	*Max.*	Normal range	
						Lower Bound	Upper Bound			*LL*	*UL*
Length Radial Neck (*mm*)	Right	100	11.80	2.07	0.21	11.39	12.21	6.08	18.04	7.74	15.85
	Left	100	11.45	1.97	0.20	11.06	11.84	6.32	16.78	7.59	15.31
	Total	**200**	**11.62**	2.02	0.14	11.34	11.91	6.08	18.04	7.66	15.59

***Box and Whisker's plot* 4**



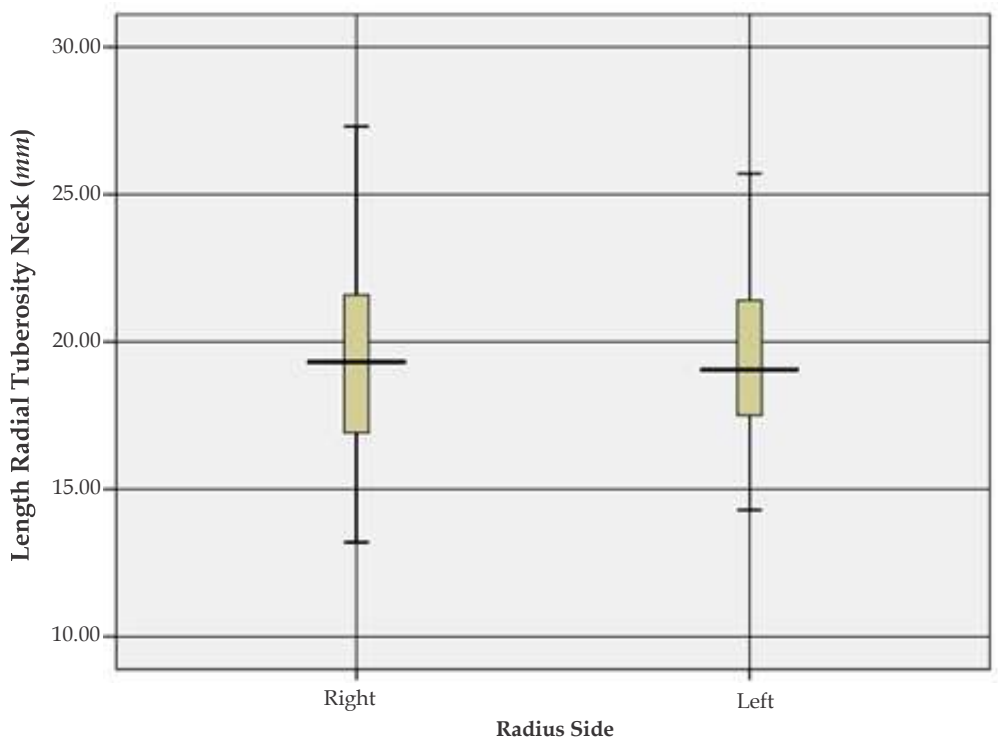
Box Plot 4: Comparing Median and Quartiles values for Length Radial Neck between Right and Left Sides.

Box Plot 4 shows that the data for length of radial neck of right and left radius. It is positively skewed, where sample 3 and 1 are outlier for right radius and sample 186 is outlier for left radius.

Table 5: Values of Length of Radial Tuberosity (*mm*).

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		*Min.*	*Max.*	Normal range	
						Lower Bound	Upper Bound			*LL*	*UL*
Length Radial Tuberosity (*mm*)	Right	100	19.41	3.28	0.33	18.76	20.06	13.20	27.31	12.98	25.84
	Left	100	19.39	2.52	0.25	18.89	19.89	14.30	25.71	14.44	24.33
	Total	200	19.40	2.92	0.21	18.99	19.81	13.20	27.31	13.68	25.12

***Box and Whisker's plot* 5**



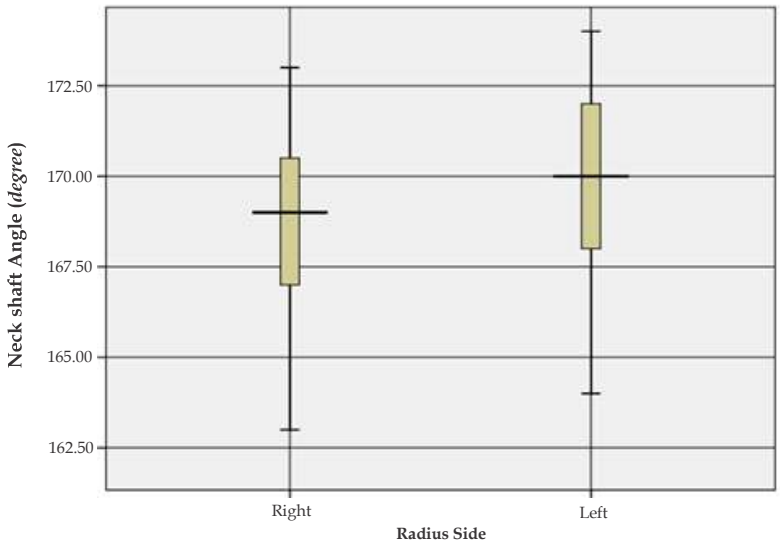
Box Plot 5: Comparing Median and quartiles values for Length of right and left radial tuberosity.

Box Plot 5 shows that the data for length of radial tuberosity of right and left radius. It is positively skewed.

Table 6: Values of Neck Shaft Angle (*degree*).

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		*Min.*	*Max.*	Normal range	
						Lower Bound	Upper Bound			*LL*	*UL*
Neck Shaft Angle (*degree*)	Right	100	168.81	2.44	0.24	168.33	169.29	163.00	173.00	164.03	173.59
	Left	100	169.76	2.27	0.23	169.31	170.21	164.00	174.00	165.31	174.21
	Total	**200**	169.29	2.40	0.17	168.95	169.62	163.00	174.00	164.58	173.99

***Box and Whisker's plot* 6**



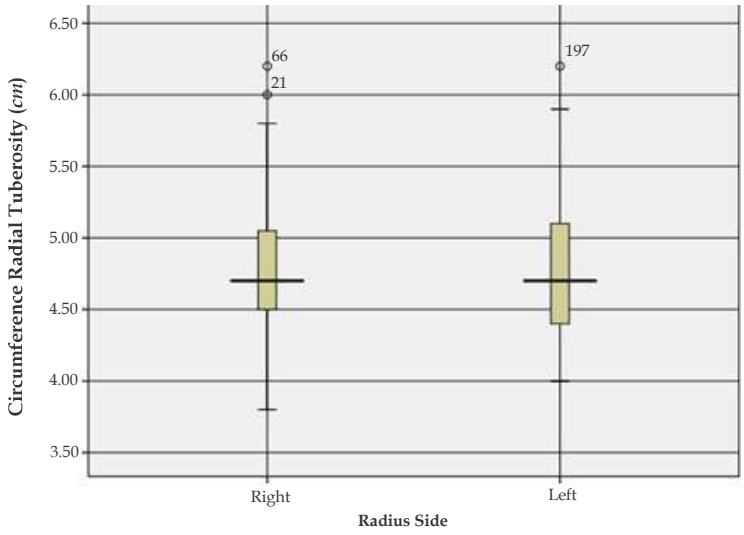
Box Plot 6: Comparing Median and Quartiles values for neck shaft angle of right and left radius.

Box Plot 6 shows that the data for neck shaft angle of right and left radius. It is negatively skewed.

Table 7: Values of Circumference at Radial Tuberosity (*cm*).

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		*Min.*	*Max.*	Normal range	
						Lower Bound	Upper Bound			*LL*	*UL*
Circumference at Radial Tuberosity (*cm*)	Right	100	4.79	0.48	0.05	4.70	4.89	3.80	6.20	3.86	5.73
	Left	100	4.78	0.47	0.05	4.68	4.87	4.00	6.20	3.86	5.70
	Total	**200**	**4.78**	**0.47**	**0.03**	**4.72**	**4.85**	**3.80**	**6.20**	**3.86**	**5.71**

***Box and wWhisker's* 7**



Box Plot 7: Comparing Median and Quartiles values for circumference at radial tuberosity of right and left radius.

Box Plot 7 shows that data for circumference at radial tuberosity of right and left radius. It is positively skewed. Where sample 21 and 66 are outlier for right radius. Sample 197 is outlier for left radius.

Discussion

Table 8: Comparison of Mean AP, Transverse Diameter and Height of Radial Head.

Study done by	Sample size	Mean AP diameter of radial head (*mm*)	Mean transverse diameter of radial head (*mm*)	Mean height of radial head (*mm*)
Berrizbeitia *et al.*(1989)[15]	1108	22	21	
Beredjiklian PK *et al.* (1999)[16]	46	23		12
Swieszkowski *et al.* (2001)[6]	17	23.36		10.14
Captier *et al.* (2002)[2]	96	21.6	21	
Mahaisavariya *et al.* (2004)[5]	40	20.5		12.9
Popovic *et al.* (2005)[4]	51	22.9	21.9	
Koslowsky *et al.* (2007)[7]	36	24.13		
Itamura *et al.* (2008)[13]	22	22.3		10.41
Puchwein *et al.* (2013)[9]	30	23	22.4	11.8
Mike *et al.* (2015)[10]	40			11.35
Gupta *et al.* (2015)[14]	50	19.15	18.55	9.05
Rajasree *et al.* (2016)[13]	100	15.43	13.43	
Present study	**200**	**20.21**	**19.65**	**10.39**

(*Abbreviation*: AP-Anteroposterior).

In present study, mean AP diameter of radial head is in close agreement with mean value obtained by Mahaisavariya *et al.* (2004).[5]

In present study mean transverse diameter of radial head is in close agreement with the study done by Gupta *et al.* (2015).[14]

In present study, mean height of radial head is in close agreement with the mean value obtained by Swieszkowski *et al.* (2001)[6] and Itamura *et al.* (2008).[13]

Table 9: Comparison of Mean Length, Length of Radial Tuberosity, Circumference at Radial Tuberosity and Neck Shaft Angle of Radius.

Study done by	Sample size	Mean length of radial neck (*mm*)	Mean length of radial tuberosity (*mm*)	Mean circumference at radial tuberosity (*cm*)	Mean of neck shaft angle of radius (*degree*)
Captier *et al.* (2002)[2]	96				168.62
Van Riet *et al.* (2004)[1]	27	13			165
Koslowsky *et al.* (2007)[8]	40	13.3			167.8
Gupta *et al.* (2015)	50	11.9	19.79		
Rajasree *et al.* (2016)[12]	100	13.57	12.20		
Mazzocca *et al.* (2007)[3]	178		22		173
Waghmare *et al.* (2012)[11]	198			5	
Mike *et al.* (2015)[10]	40			4.87	
Present study	**200**	**11.62**	**19.40**	4.78	169.29

In present study, mean length of radial neck and radial tuberosity are in close agreement with the study done by Gupta *et al.* (2015).[14]

In present study, mean circumference at radial tuberosity of radius is in close agreement with the mean values obtained by Waghmare *et al.* (2012)[11] and Mike *et al.* (2015).[10]

In present study, mean neck shaft angle of radius is in close agreement with the study done by Captier *et al.* (2002).[2]

Conclusion

The dimension and shape of the radii may be useful for construction and manufacturing of prosthesis of radius with accuracy. The morphometric data may be significant in surgical procedures like reconstruction of biceps tendon.

Conflict of interest: There is no conflict of interest.

References

1. Van Riet RP, Van Glabbeek F, Neale PG, *et al.* Anatomical considerations of the radius. ClinAnat. 2004;17:564–69.
2. Captier G, Canovas F, Mercier N, *et al.* Biometry of the radial head: Biomechanical implications in pronation and supination. Surg Radiol Anat. 2002 Dec;24(5):295–301.
3. Mazzocca AD, Cohen M, Berkson E, *et al.* The anatomy of the bicipital tuberosity and distal biceps tendon. J Shoulder Elbow Surg. 2007 Jan–Feb;16(1):122–27.
4. Popovic N, Djekic J, Lemaire R, *et al.* Comparative study between proximal radial morphology and the floating radial head prosthesis. J Shoulder Elbow Surg. 2005 Jul–Aug; 14(4):433–40.
5. Mahaisavariya B, Saekee B, Sitthiseripratip K, *et al.* Morphology of the radial head: A reverse engineering based evaluation using three-dimensional anatomical data of radial bone. Proc Inst Mech Eng H. 2004;218(1):79–84.
6. Skalski K, Pomianowski S, Kedzior K, *et al.* The anatomic features of the radial head and their implication for prosthesis design. Clin Biomech (Bristol, Avon). 2001 Dec;16(10):880–87.
7. Koslowsky TC, Germund I, Beyer F, *et al.* Morphometric parameters of the radial head: An anatomical study. Surg Radiol Anat. 2007 Apr;29(3):225–30.
8. Koslowsky TC, Beyer F Germund I, *et el.* Morphometric parameters of the radial neck: An anatomical study. Surg Radiol Anat. 2007 Jun;29(4):279–84.
9. Puchwein P, Heidari N, Dorr K, *et al.* Computeraided analysis of radial head morphometry. Orthopaedics. 2013;36:e51–7.
10. Mike IN, Okon ES, Olawale BA, *et al.* Regression equations for the estimation of radial length from its morphometry in South-West Nigerian population. J Exp Clin Anat. 2015;14:51–56.
11. Waghmare JE, Deshmukh PR, Waghmare PJ. Determination of sex from the shaft and tuberosity of radius: A multivariate discriminant function analysis. J Biomed Res. 2012;23(1):115–18.
12. Gali R, Todimaldinnae S., Devi S. *et al.* Morphology and morphometry of proximal dry radii in south coastal population. IJRDO - Journal of Health Sciences and Nursing. 2016;1(11):69-91.
13. Itamura JM, Roidis NT, Chong AK, *et al.* Computed tomography study of radial head morphology. J Shoulder Elbow Surg. 2008;17(2):347–54.
14. Gupta C, Kalthur SG, Malsawmzuali JC, *et al.* A morphological and morphometric study of proximal and distal ends of dry radii with its clinical implications. Biomed J. 2015;38:323–28.
15. Berrizbeitia EL. Sex determination with the head of the radius. J Forensic Sci. 1989 Sep; 1206:(5)34–13.
16. Beredjiklian PK, Nalbantoglu U, Potter HG, *et al.* Prosthetic radial head components and proximal radial morphology: A mismatch. J Shoulder Elbow Surg. 1999 Sep–Oct;8(5):471–75.

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Journal of Forensic Chemistry and Toxicology	2	10000	9500	781	742
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Tattooed Individuals with Psychotic Symptoms

Anitha MR[1], Vijayanath V[2]

Abstract

Tattooing is gaining more importancein modern society, and the speed is picking up faster. And its popularity is not restricted to only one gender especially in adulthood. *Aim:* To assess the Psychotic symptoms in tattooed individual. *Methodology:* We conducted a cross-sectional descriptive study using Brief Psychiatric Rating Scale (BPRS). *Results:* Results are depicted in the table with the majority of statistical significance. *Discussion:* Tattooed individuals may have the psychotic symptoms earlier to getting the tattooed done or may develop the psychotic symptoms after getting the tattoo, which was not very much clear in this present study. But definitely, these tattoos are related with the use of substances which causes the psychotic symptoms. *Conclusion:* As there is a definite correlation between the use of the substances and having a tattoo. This could be used in the form of signs for understanding the other substance user. And literature review confirms the use of the substance with psychotic symptoms. In the same way, tattooing also indicates the existence of the psychotic symptoms.

Keywords: Symptoms; Psychosis; tattoo.

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Introduction

The term tattoo has been derived fromTahitian term ta tatau, meaning appropriate, balanced, and fitting[1] and tattooing is defined as the insertion into the skin of any coloring materials designed to leave a semi-permanent or permanent mark on the body[2]. Tattooing is gaining more importance in the modern society, and the speed is picking up faster. And its popularity is not restricted to only one gender especially in adulthood. Literature directs the psychological dependence of these tattooed individuals; whereas this can be *vis a vis* tattooed individual may be suffering from a psychological disorder. For the same reason, few physicians have suggested thinking about the possibility of a wide range of psychopathology in these tattooed individuals. Some authors even concluded to a certain extent that if there is a tattoo of tumbling dice or a deck of card which signifies "fate" were having psychopathic deviant and diagnosed to be schizophrenic.[3] In the study by Farrow *et al.* indicated that drug and alcohol abuse was found to be very common in the individuals having tattoos easily visible.[4] In fact, tattoos are classified as "criminal tattoos" and non-criminal tattoos depending on the components of the tattoo. Criminal tattoos are the one which reflects the conflict with the law using such symbols which are high in the hierarchy of criminal activity. And non-criminal tattoos are not having any such conflicts with the law and these are always with the self-interest of the individual. And the number of tattoos on the individuals on an individual indicates his deviation from others in

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society. As the heavily tattooed individual are more deviant compared to a less tattooed individual. Tattoos are also considered as the highly encoded language of communication in which every tattoo has a specific meaning hinting the psychological backup of the individual.

Aim

To assess the Psychotic symptoms in a tattooed individual.

Methodology

We conducted a cross-sectional descriptive study using Brief Psychiatric Rating Scale (BPRS).

The Brief Psychiatric Rating Scale (BPRS) is a widely used methodology for assessing and scoring the positive, negative, and affective symptoms of individuals who have psychotic disorders, commonly seen in schizophrenia. It is highly-valuable for documenting the efficacy of treatment in patients who have the disease. It should be administered by a clinician who is knowledgeable in psychotic disorders and able to interpret and constructs used in the assessment. The BPRS contains 18 symptoms construct and takes about *20–30 minutes* for the interview and scoring. The rater should enter a number ranging from 1 (not present) to 7 (extremely severe), 0 is entered if the item is not assessed [5].

Results

Table 1: Tattoed individuals relation with Psychosis and Age.

Age	Psychosis								Total	Sig
	1	2	4	5	6	7	10	14		
<18	4	0	6	2	1	0	0	0	**13**	**0.006***
19–21	5	0	15	12	1	0	1	1	**35**	
22–24	1	1	3	3	2	0	0	0	**10**	
25–27	0	0	0	0	1	1	0	0	**2**	
>28	0	0	1	1	0	0	0	0	**2**	
Total	**10**	**1**	**25**	**18**	**5**	**1**	**1**	**1**	**62**	

Table 2: Showing relation with Psychosis and Gender.

Gender	Psychosis								Total	Sig
	1	2	4	5	6	7	10	14		
Male	5	1	21	8	1	1	0	1	**38**	
Female	5	0	4	10	4	0	1	0	**24**	**0.034**
Total	**10**	**1**	**25**	**18**	**5**	**1**	**1**	**1**	**62**	

Table 3: Showing relation with Psychosis and Religion.

Religion	Psychosis								Total	Sig
	1	2	4	5	6	7	10	14		
Hindu	9	1	23	17	3	0	1	1	**55**	**0.014**
Muslim	1	0	0	0	0	1	0	0	**2**	
Christian	0	0	0	1	0	0	0	0	**1**	
Jain	0	0	1	0	1	0	0	0	**2**	
No answered	0	0	1	0	1	0	0	0	**2**	
Total	**10**	**1**	**25**	**18**	**5**	**1**	**1**	**1**	**62**	

Table 4: Showing relation with Psychosis and Residence.

Residence	Psychosis								Total	Sig
	1	2	4	5	6	7	10	14		
Urban	6	0	17	15	5	0	1	0	**44**	**<0.01***
Rural	4	0	8	2	0	1	0	1	**16**	
No answered	0	1	0	1	0	0	0	0	**2**	
Total	**10**	**1**	**25**	**18**	**5**	**1**	**1**	**1**	**62**	

Table 5: Showing relation with Psychosis and Complaints Post Tattooing.

Complaints Post Tattooing	Psychosis								Total	SIG
	1	2	4	5	6	7	10	14		
No Answered	4	0	9	6	0	0	0	1	**20**	**<0.01***
Good	0	0	1	0	0	0	0	0	**1**	
No Complaints	4	1	13	11	4	1	0	0	**34**	
Pain	1	0	0	0	0	0	0	0	**1**	
Redness Burning Sensation, Itching	0	0	0	1	0	0	0	0	**1**	
Redness for A-week	0	0	0	0	1	0	0	0	**1**	
Shaded	0	0	0	0	0	0	1	0	**1**	
Small Swelling	0	0	1	0	0	0	0	0	**1**	
Swelling of Hand	0	0	1	0	0	0	0	0	**1**	
Uncontrollable Pain	1	0	0	0	0	0	0	0	**1**	
Total	**10**	**1**	**25**	**18**	**5**	**1**	**1**	**1**	**62**	

Table 6: Showing relation with Psychosis and no of Tattoo.

No of Tattoo	Psychosis								Total	Sig
	1	2	4	5	6	7	10	14		
1	8	1	10	14	4	0	1	0	**38**	**<0.01***
2	1	0	9	2	0	0	0	0	**12**	
3	1	0	5	1	1	0	0	0	**8**	
4	0	0	0	0	0	1	0	0	**1**	
5	0	0	1	0	0	0	0	0	**1**	
8	0	0	0	1	0	0	0	0	**1**	
61	0	0	0	0	0	0	0	1	**1**	
Total	**10**	**1**	**25**	**18**	**5**	**1**	**1**	**1**	**62**	

Table 7: Showing relation with Psychosis and Occupation.

Occupation	Psychosis								Total	Sig
	1	2	4	5	6	7	10	14		
Semi-skilled	0	0	0	1	0	1	0	0	**2**	**0.014**
Labour	0	0	1	0	0	0	0	0	**1**	
Professional	0	0	0	0	1	0	0	0	**1**	
Student	9	1	23	17	4	0	1	1	**56**	
No answered	1	0	1	0	0	0	0	0	**2**	
Total	**10**	**1**	**25**	**18**	**5**	**1**	**1**	**1**	**62**	

Table 8: Showing relation with Psychosis and Education.

Education	Psychosis								Total	Sig
	1	2	4	5	6	7	10	14		
Illiterate	0	0	1	0	0	1	0	0	**2**	**0.002***
Literate	0	0	1	1	0	0	0	0	**2**	
Primary/ Secondary/SSLC	0	0	2	1	0	0	0	0	**3**	
PUC	4	0	9	9	1	0	0	0	**23**	
Graduate	4	0	10	5	4	0	1	1	**25**	
PG/PhD	1	0	2	2	0	0	0	0	**5**	
No answered	1	1	0	0	0	0	0	0	**2**	
Total	**10**	**1**	**25**	**18**	**5**	**1**	**1**	**1**	**62**	

Discussion

The study was aimed to look at the possible relation between psychotic symptoms and having a tattoo. When the same data has been subjected to statistics it has shown good values of significances and the results have been depicted in **Tables 1–8**.

Since the study was conducted in professional

colleges obviously the sample size is more in the second decade. In the case of a tattooed individual with the age group is compared with those having psychotic symptoms have shown significance statistically. The psychosis scoring is; Score 1–6 = 0–30; 7–8 = 31–40; 9–10 = 41–50; 11–14 = 51–70. BPRS (Brief Psychiatric Rating Scale) and CGI (Clinical Global Impression); Normal <30; mildly ill = 31; moderately ill = 41; markedly ill = 53.

The age group in the tattooed individuals is compared with the individuals having psychotic symptoms has shown:

The psychosis scoring is as follows; score 1–6 = 0–30; 7–8 = 31–40; 9–10 = 41–50; 11–14 = 51–70. BPRS (Brief Psychiatric Rating Scale) and CGI (Clinical Global Impression); Normal <30; mildly ill = 31; moderately ill = 41; markedly ill = 53. The psychosis scoring is divided into following categories for the statistical purpose the psychotic scoring by using BPRS is from 0–70; The numbering for statistical purpose is as follows 1–6 = 0–30; 7–8 = 31–40; 9–10 = 41–50; 11–14 = 51–70. Where 1–6 is normal; 7–8 is mildly ill; 9–10 is moderately ill; 111–14 is markedly ill. BPRS (Brief Psychiatric Rating Scale) and CGI (Clinical Global Impression); Normal <30; mildly ill = 31; moderately ill = 41; markedly ill = 53. The psychosis scoring is as follows; score 1–6 = 0–30; 7–8 = 31–40; 9–10 = 41–50; 11–14 = 51–70. BPRS (Brief Psychiatric Rating Scale) and CGI (Clinical Global Impression); Normal <30; mildly ill = 31; moderately ill = 41; markedly ill = 53. The psychosis scoring is as follows; score 1–6 = 0–30; 7–8 = 31–40; 9–10 = 41–50; 11–14 = 51–70. BPRS (Brief Psychiatric Rating Scale) and CGI (Clinical Global Impression); Normal <30; mildly ill = 31; moderately ill = 41; markedly ill = 53.

**Highly Significant at a = 0.01 (99% Confidence Interval).*

The association between tattooing and smoking may be largely related to non-rational decision making and non-planning behavior. Some studies found a significant association between tattooing and smoking.[6-7] And also high impulsive and risky decision-making behavior in the tattoo group may be related to smoking as a confounding factor. Some studies clearly indicate impulsivity as a precursor for smoking.[8] In addition, the association between tattooing and smoking may be related to the fact that both may have addictive characteristics.[9]

Conclusion

Even though the tattoos are used as languages for substance use, it has been reported very seldom in the literature about the development of Psychotic symptoms in the tattooed individual. It was not clear about the psychotic symptoms; whether the symptoms were existing before getting the tattoo done or after having the tattoo from our study as well as it was a pilot study to start the study in the large group. So the efforts will be made in future studies to categorize the relation of psychotic symptoms with relation to tattoo.

References

1. Kaatz M Elsner, P and Bauer A. Body-modifying concepts and dermatologic problems: Tattooing and piercing. Clinics in Dermatology. 2008;26:35–4.
2. Chalmers C. Charting the existence and approaches to the management of the tattooing and body piercing industry: A historical overview. Journal of Infection Prevention. 2009;10:102–5.
3. Ferguson-Rayport S, Griffith R, Straus E. The psychiatric significance of tattoos. Psychiatr Q; 1955;29:112–31.
4. Farrow JA, Schwartz RH, Vanderleeuw J. Tattooing behavior in adolescence. A Comparison study. American Journal of Diseases of Children. 1991;145:184–87.
5. Overall, JE, Gorham DR. The Brief Psychiatric Rating Scale (BPRS): Recent developments in ascertainment and scaling. Psychopharmacology Bulletin. 1988;24:97–9.
6. Drews DR, Allison CK, Probst JR. Behavioral and self-concept differences in tattooed and non-tattooed college students. Psychol Rep; 2000; 86(2):475–81.
7. Bosello R, Favaro A, Zanetti T *et al.* Tattoos and piercings in adolescents: Family conflicts and temperament. Riv Psichiatr. 2010;45(2):102–6.
8. Kvaavik E, Rise J. How do impulsivity and education relate to smoking initiation and cessation among young adults? J Stud Alcohol Drugs. 2012;73(5):804–10.
9. Tate J, Shelton B. Personality correlates of tattooing and body piercing in a college sample: The kids are all right. Pers Indiv Differ. 2008;45:281–85.

Original Article

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An Anthropometric Study of Stature Estimation from Measurements of Hands in Tribals of Udaipur in Rajasthan Using Regression Analysis

Charu Taneja

Abstract

Background: Estimation of stature plays an outstanding role in personal identification. It has a significant importance in forensic anthropometry. *Objective:* The present study is an attempt to evaluate a possible correlation between stature of an individual and hand length and hand breadth in tribal population of Udaipur. *Materials and Methods:* The present study was conducted on 200 tribal males and 200 tribal females in age group of 18–32 *years*. All the measurements were done by using standard anthropometric instruments and standard anthropometric techniques. *Results:* There was a positive but low correlation between height and various hand parameters with with increase in height there is increase in the hand parameters but with less relationship for statistical analysis SPSS (Version 17) was used. *Conclusion:* The present study has provided regression equations for various hand parameters hand length and hand breadth.

Keywords: Stature; Hand length; Hand breadth; Regression equation.

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Introduction

Estimation of stature has a significant importance in the field of forensic anthropometry. Estimation of stature of an individual from the skeletal material or from the mutilated or amputated limbs or parts of limbs has obvious significance in personal identification in the events of murders, accidents or natural disasters mainly concerns with the forensic identification analysis. To assess the height of an individual, from measurements of different parts of the body, has always been of immense interest to anatomists, anthropologists and forensic experts.

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Prediction of the dimensions of body segments is useful in many areas of modern science. For example, in growth and development the use is made of relationship between body segments in the assessment of normal growth as well as in specific syndromes.

Materials and Methods

The study comprised of 200 tribal Males and 200 Females of Udaipur between age group of *18–32 years*. A written valid informed consent was taken from each of the participants. The subjects were apparently healthy and without any physical deformity. All measurements were recorded to the nearest millimeter using standardized anthropometric measuring equipment; stature meter and digital vernier calipers. The data was tabulated, analyzed and subjected to statistical calculations. We analyzed our data using SPSS (Version 17.0).

Stature: The height of the individual was measured between vertex and the floor, when the person is standing erect, in anatomical position and head in the Frankfort plane.

Hand length: With the help of Vernier Calipers, Hand length was measured as a distance between midpoint of line joining styloid process of radius and ulna and tip of third finger.

Hand breadth: With the help of Vernier Calipers, Hand breadth was measured as a distance between the most prominent point on lateral aspect of second metacarpal and most prominent point on medial aspect of head of fifth metacarpal.

Results

The following observations were calculated after statistical analysis:

Table 1 shows descriptive statistics for various parameters studied in Males and Females. The average stature of Females was **1550.41 ± 91.947 *mm*** and ranged between 1375 and 1711 *mm*. The hand lengths measured 168 *mm* (approxi.) and hand breadths measured approximately 72 *mm*. Table also shows descriptive statistics for various parameters studied in Males. The average stature of Males was **1605.735 ± 82.295 *mm*** and ranged between 1426 and 1800 *mm*. The hand lengths measured 172 *mm* (approxi.) and hand breadths measured approximately 82 *mm*.

Ho: To assess the statistical difference between observations of right and left sides in Males and Females paired sample *t*-test was performed.

Significant differences between the observations of right and left sides in Males and Females were observed using paired sample *t*-test and thus null hypothesis was rejected. All the parameters in Males and Females were highly significant (as shown in **Table 2)**.

There was a positive but low correlation between height various hand parameters like hand length and hand breadth in Males and Females. With increase in height, there is increase in the hand parameters but with less relationship (as in **Table 3**).

Linear regression equations predicting stature using various hand parameters in Males and Females. The equations also exhibit standard error of estimate (S.E.E.). The S.E.E. predicts the deviations of estimated stature from the actual stature. It ranged between 92.10 and 92.148 in females. Right Hand Breadth (R.H.B.) in Females exhibited a lower value and gives better reliability in prediction of stature (as in **Table 4**). In Males it ranged between 82.154 and 82.281. A low value indicates greater reliability in the estimated stature. Hand length exhibits a lower value in Males and gives better reliability in prediction of stature (as shown in **Table 4**).

Table 1: Descriptive Statistics of Parameters of both Males and Females under Study.

Column	Size	Mean	S.D.	S.E.	Range	Max.	Min.	Median
Female Height	200	1550.41	91.947	6.502	336	1711	1375	1557.5
Female RHL	200	168.112	11.981	0.847	48.14	191.31	143.17	167.5
Female LHL	200	167.853	11.989	0.848	48.13	191.13	143	167.34
Female RHB	200	72.579	7.593	0.537	31.5	88.2	56.7	72.5
Female LHB	200	72.297	7.591	0.537	31.81	88.04	56.23	72.21
Male Height	200	1605.735	82.295	5.819	374	1800	1426	1602
Male RHL	200	172.242	12.436	0.879	48.5	190	141.5	173.65
Male LHL	200	172.039	12.545	0.887	48.7	190	141.3	173.72
Male RHB	200	82.146	6.284	0.444	27.68	98.38	70.7	81.65
Male LHB	200	81.891	6.336	0.448	28.17	98.2	70.03	81.25

Table 2: Significance between right and left side of both Males and Females (Paired Sample *t*-test).

	Sample	*t*-value	df	Significance (2-tailed)
Pair 1	Female right hand length – hand length Female left	13.204	199	0.000 **
Pair 2	Female right hand breadth – Female left hand breadth	5.949	199	0.000 **
Pair 3	Male right hand length – Male left hand length	4.424	199	0.000 **
Pair 4	Male right hand breadth – Male left hand breadth	6.150	199	0.000 **

***Highly significant*.

Table 3: Correlation between Height and Various Hand Parameters in both Males and Females under study.

Parameters	Pearson correlation	Significance (2-tailed)
Female right hand length	0.026	0.717
Female left hand length	0.027	0.701
Female right hand breadth	0.041	0.569
Female left hand breadth	0.033	0.639
Male right hand length	0.085	0.230
Male left hand length	0.092	0.196
Male right hand breadth	0.086	0.225
Male left hand breadth	0.073	0.303

Table 4: Linear regression Equations for various Parameters studied in both Male and Female.

Female	Male
Height = 1517.100 + 0.198 × RHL ± 92.148	Height = 1508.619 + 0.564 × RHL ± 82.203
Height = 1515.241 + 0.210 × LHL ± 92.144	Height = 1502.008 + 0.603 × LHL ± 82.154
Height = 1514.802 + 0.491 × RHB ± 92.10	Height = 1513.106 + 1.128 × RHB ± 82.197
Height = 1521.182 + 0.404 × LHB ± 92.127	Height = 1527.806 + 0.952 × LHB ± 82.281
Height = 1516.165 + 0.204 × H Length ± 92.146	Height = 1505.215 + 0.584 × H Length ± 82.179
Height = 1517.934 + 0.448 × H Breadth ± 92.115	Height = 1520.343 + 1.041× H Breadth ± 82.240

Discussion

The following comparisons of various similar studies in a tabulated form in Table 5.

There was positive but low correlation between height and various hand parameters. Previous studies have found that the regression equations using anatomical dimensions of one population do not apply to another. The same was found in our study, where our data differs from data of previous studies of other ethnic groups. We also found that the regression equations of one sex cannot be applied to the other even when estimating stature in same ethnic group. So in this study we derived a separate regression equations to estimate stature from hand length and hand breadth. From the above facts, it is clear that if either of the measurement (hand length, hand breadth or total height) is known the other can be calculated and this method of stature estimation can be used by law enforcement agencies and forensic scientists. There are a lot of variations in estimating stature from hands among people of different region and race. No such type of study was carried out in Udaipur of Rajasthan. Hence there is a need to conduct more studies among people of different regions so that stature estimation becomes more reliable and there is easily identification of an individual. In this study only healthy individuals are included so the results may not be applicable to the persons having any deformity or any congenital abnormality (as shown in Figs.1–4).

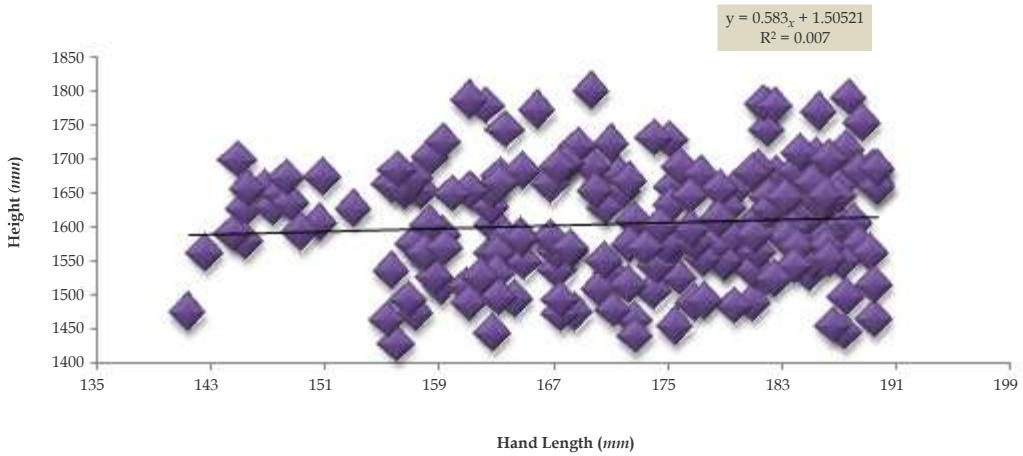

Fig. 1: Correlation between Male Height and Male Hand Length.

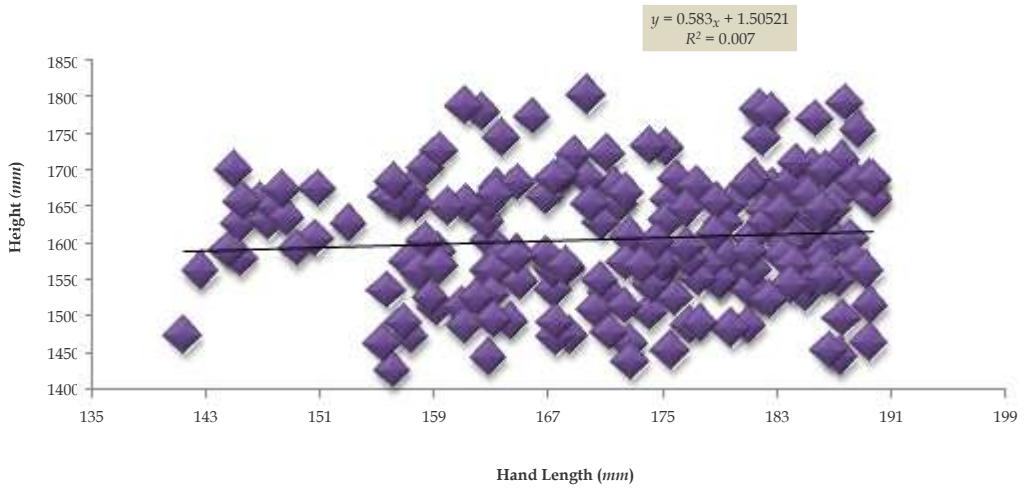

Fig. 2: Correlation between Male Height and Male Hand Breadth.

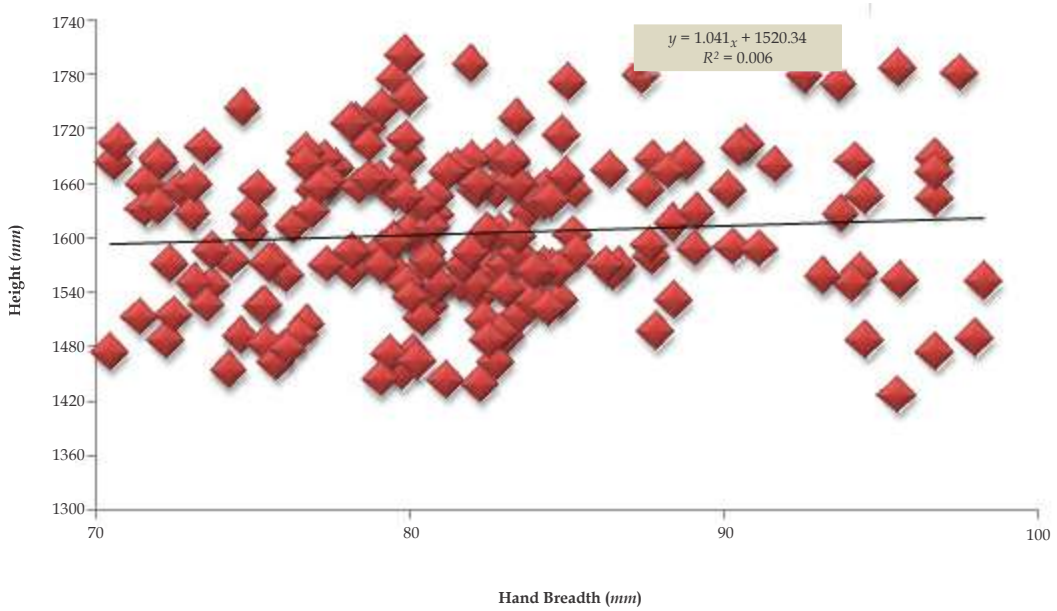

Fig. 3: Correlation between Female Height and Female Hand Length.

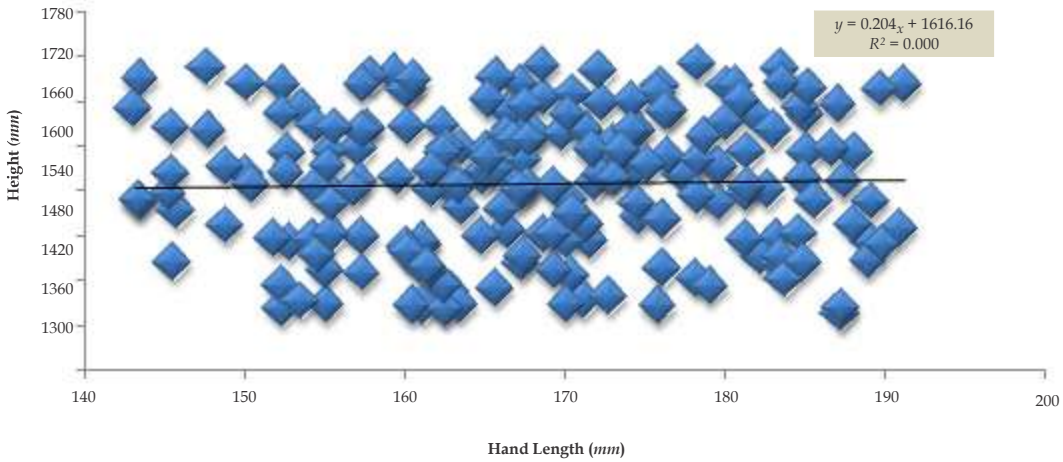

Fig. 4: Correlation between Female Height and Female Hand Length.

Table 5:

Sl. No.	Population	Sex	Area	Author	Year	Regression Equation	S.E.E.	Value of *r*
1.	Jat sikhs	Male	Punjab	Dr OP Jasuja [3]	2004	H = 69.513 + 5.223 × Hand Length (R)	4.003	0.502(R)
2.	Jat sikhs	Male	Punjab	Dr OP Jasuja[3]	2004	H = 84.742 + 4.491 × Hand Length (L)	4.003	0.452(L)
3.	Turks	Male	Adana, Turkey	Sultan G Sanli[3]	2005	H = 439.52 + 3.29 × Hand Length	42.66	0.722
4.	Rajputs	Male	Himachal	Kewal Krishan[4]	2007	H = 88.243 + 4.39 × Hand Length	5.17	0.304
5.	North Indians	Male	Mangalore	Prateek Rastogi[5]	2008	H = 81.343 + 4.78 × Hand Length	5	0.659
6.	South Indians	Male	Mangalore	Prateek Rastogi[5]	2008	H = 69.006 + 5.469 × Hand Length	4.85	0.731
7.	Medical Students	Male	Galle, Srilanka	I. Ilayperuma[2]	2009	H = 103.732 + 3.930 × Hand Length	5.22	0.58
8.	Tribals	Male	Udaipur	Charu Taneja	2014	H = 1505.215 + 0.584 × Hand Length	82.179	.083
9.	Tribals	Female	Udaipur	Charu Taneja	2014	H = 1517.934 + 0.448 × Hand Breadth	92.115	0.037
10.	Tribals	Female	Udaipur	Charu Taneja	2014	H = 1517.934 + 0.448 × Hand Breadth	92.115	0.037
11.	Jat sikhs	Male	Punjab	Dr OP Jasuja[3]	2004	H = 69.513 + 5.223 × Hand Length (R)	4.003	0.502(R)
12.	Jat sikhs	Male	Punjab	Dr OP Jasuja[3]	2004	H = 84.742 + 4.491 × Hand Length (L)	4.003	0.452(L)
13.	Turks	Male	Adana, Turkey	Sultan G Sanli[6]	2005	H = 439.52 + 3.29 × Hand Length	42.66	0.722
14.	Rajputs	Male	Himachal	Kewal Krishan[4]	2007	H = 88.243 + 4.39 × Hand Length	5.17	0.304
15.	North Indians	Male	Mangalore	Prateek Rastogi[5]	2008	H = 81.343 + 4.78 × Hand Length	5	0.659
16.	South Indians	Male	Mangalore	Prateek Rastogi[5]	2008	H = 69.006 + 5.469 × Hand Length	4.85	0.731
17.	Medical Students	Male	Galle, Srilanka	I. Ilayperuma[2]	2009	H = 103.732 + 3.930 × Hand Length	5.22	0.58
18.	Tribals	Male	Udaipur	Charu Taneja	2014	H = 1505.215 + 0.584 × Hand Length	82.179	.083
19.	Rajputs	Female	Himachal	Kewal Krishan[4]	2007	H = 110.39 + 6.13 × Hand Breadth	4.5	0.503
20	North Indians	Female	Mangalore	Prateek Rastogi[5]	2008	H = 97.058 + 8.570 × Hand Breadth	5.4	0.46
21.	South Indians	Female	Mangalore	Prateek Rastogi[5]	2008	H = 85.503 + 10.767 × Hand Breadth	5.73	0.592
22.	Volunteers	Female	Turkey	Abdi Ozaslan[1]	2012	H = 1298.32 + 4.25 × HB	62.27	0.257
23.	Jat Sikhs	Female	Punjab	Dr OP Jasuja[3]	2004	H = 133.961 + 1.473 × Hand Length	5.127	0.529(R)
24.	Turks	Female	Adana, Turkey	Sultan G Sanli[6]	2005	H = 743.11 + 2.38 × Hand Length	34.96	0.709
25.	Rajputs	Female	Himachal Pradesh	Kewal Krishan[4]	2007	H = 81.314 + 4.42 × Hand Length	3.78	0.33
26.	North Indians	Female	Mangalore	Prateek Rastogi[5]	2008	H = 80.200 + 4.60 × Hand Length	4.24	0.717
27.	South Indians	Female	Mangalore	Prateek Rastogi[5]	2008	H = 83.044 + 4.45 × Hand Length	3.76	0.678
28.	Medical Students	Female	Galle, Srilanka	I. Ilayperuma[2]	2009	H = 93.689 + 3.625 × Hand Length	5.75	0.59
29.	Volunteers	Female	Turkey	Abdi Ozaslan[1]	2012	H = 1116.56 + 2.80 × Hand Length	60.32	0.309
30.	Tribals	Female	Udaipur	Charu Taneja	2014	H = 1516.156 + 0.204 × Hand Length	92.146	0.026

Conclusion

It is concluded that the dimensions of hands can provide good reliability in estimation of stature. The right hand breadth gives better prediction of stature than the left hand breadth in case of female tribals of Udaipur. In males the left hand length gives better prediction of stature than the right hand length in case of male tribals of Udaipur.

References

1. Abdi O, Beytullah K, Melek OK. Predictive role of hand and foot dimensions in stature estimation. Rom J Leg Med. 2012;(20):41–6.
2. Isurani I, Gananda N, Nadeeka P. Prediction of stature based on hand length. Galle Medical Journal. 2009 Sep;14(1):15–8.
3. Jasuja OP. Estimation of stature from hand and phalange length. Journal of Indian Academy of Forensic Medicine. 2004;26(3):100–106.
4. Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in north Indian population. Journal Clin. Forensic Med. 2007;14(6):327–32.
5. Rastogi P, Nagesh KR. Estimation of stature from hand dimensions of North and South Indians. Leg Med (Tokyo). 2008 Jul;10(4):185–89.
6. Sanli SG, Kizilkanat ED, Boyan N, *et al*. Stature estimation based on hand length and foot length. Clin Anat. 2005;18:589–96.
7. Shende S, Tirpude BC, More S. To study the correlation between hand and foot dimensions and stature among the population in a district of Maharashtra situated in central India. International Journal of Medical Toxicology Legal Medicine. 2012 Dec;15(1):44–8.

Original Article

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An Approach to Know Effective Techniques in Processing and Cleaning of Bones

Dhanesh Kumar Sharma[1], Nikita Chaudhary[2]

Abstract

Introduction: As a part of anatomy teaching curriculum and three-dimensional demonstrations in Osteology, preparation of bones plays an important role. Also, to bring more information regarding sites of muscular attachments and course of neurovascular structures in a region, study of bones consistently maintains its own essentiality. Osteology is an important aspect of forensic anatomy too. This study is to know the effective techniques in bone cleaning among the various methods like maceration with water, boiling, enzymes, chemicals, bugs, leaving open above ground and burial under soil. *Methods:* Dissected cadavers buried for a period of about one year were dugout for the skeleton. Bones were also collected from the dissected cadavers directly without burial, with the help of technicians by using common instruments in the dissection hall like scalpels, scissors, and forceps to leave the bones with minimal soft tissue attachments. Then these bones were put in different solutions like H_2O_2, NaOH, Limewater and Plain water with sun exposure in daytime for a week. Finally the bones were then washed in running water and air dried under the fan. *Results:* The best method found suitable for the clean and white bone preparation in this study was using the chemical Limewater. The smell of the bones prepared and the process is not as strong/difficult and distasteful as perceived in the other methods like burial, leaving open above ground, boiling, using enzymes and bugs etc. *Discussion:* Most of the methods of bone preparation are tedious and time consuming. Also, they need training and expertise of persons doing these procedures. In present study we found that using Limewater (a clear liquid consisting of calcium hydroxide) with sunlight exposure in daytime for a week time, was the best method in the terms of less time required, the odourless and white colour and bones prepared and the simplicity of the process. So we are now able to find out the most suitable organic method by which bones can be prepared with least damage and for a good presentable appearance.

Keywords: Maceration; Chemical preparation; Burial; Osteology; Cleaning.

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Introduction

Human Anatomy is the foundation and basic subject of medical science and osteology or study of bones is the essential part of anatomy teaching curriculum and is incomparable in the ability to provide 3-dimensional presentation in osteology. There are a number of methods or techniques for bone preparation like maceration of dissected cadaver through submersion in water for *a time* in cold or hot water; boiling; burying in the ground; using biological washing powder, enzymes like pepsin, chemicals like H_2O_2, NaOH, Limewater, dermestid beetles; leaving bones open above ground to fasten the removal of the attached soft tissues from the bones.

Bones are very essential part of anatomy teaching curriculum.[1] Preparation of bones involves soft tissue removal or bone cleaning, bone bleeching, bone articulation and labeling.[2] Preparation of bones from cadavers by maceration has been shown to elicit strong and distasteful odour, is time consuming

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and takes longer time in large animals.[3] Dermestids the flesh-eating beetles have been used for bone cleaning in small animals and is said to be the best method. Cold or warm-water maceration has been used as standard maceration techniques. Boiling and subsequent mechanical cleaning of skeletal material is also used.[4] Maceration with organic chemicals can be performed with enzymes such as papain/pepsin or with washing powders containing enzymes.[5] All solutions eventually remove or dissolve the soft tissues from the external surface of the bone. Solutions with different pH have significant and interesting effects on bones to the varying degrees.[6]

Cleaning treatments using bleach, H_2O_2, ethylenediaminetetraacetic acid/papain, room temperature water and detergent/sodium carbonate followed by degreasing had low DNA concentrations and failed to generate nuclear polymerase chain reaction (PCR) products. Study shows that traditionally "conservative" maceration techniques are not necessarily the best methods to yield DNA from skeletal tissue.[7] Maceration techniques remove soft tissue by the destruction of biomolecules, but the applied techniques may also affect the morphology and the molecular integrity of the hard tissue itself.[5]

Materials and Methods

In this study for bone cleaning and preparation we adopted method using Water, H_2O_2 (50%), 5% solution of NaOH and Limewater in human bones both small and large. Dissected cadavers buried for a period of about *1year* were dugout for the skeleton. We also used the bones of dissected cadavers in the dissection hall. The muscles were carefully dissected and teased from the bones using common instruments in the dissection hall (scalpels, scissors, forceps) to leave the bones with minimal soft tissue attachments. They were then put into different plastic buckets/containers containing water, H_2O_2, NaOH and Limewater enough to submerge the bones. Necessary precaution for handling these chemical solutions were taken. Then the bones in the buckets/containers were placed under the sunlight in daytime for *4/7 days*. The bones were then washed in running water and air dried under the fan. Parameters such as colour change and odour of the bones were noted. Percentage of bone recovery was noted and thereafter photographs of the bones were taken.

Results

The best method suitable for bone preparation in this study we found is use of chemical Limewater. The method we used is not time consuming, bones appear most white as compared with other chemicals like H_2O_2 and NaOH. **Table 1** is showing comparison of bone cleaning with these chemicals. The smell of the bones and the process is not as strong/difficult and distasteful as perceived in the other methods like burial or leaving bones open above ground. The main disadvantage with some chemicals is the cracks made on the bones, which is also not found with this chemical limewater. It is also observed that when sunlight exposure is avoided then bone whiteness is less and time duration of bone preparation increases for getting similar result as with sunlight exposure. This study has highlighted the advantages of chemical method over maceration and burial methods in the preparation of bone. Amongst the chemicals, the use of limewater gave the best result. Another most obvious feature is that result in the form of cleaning and whiteness was found equal with small as well as large human bones. Result about whiteness of bones after *7 days* was most satisfactory than that of after *4 days* **(Fig.1).**

Table 1: Comparison of results from media used in Methods of Bone Preparation.

Parameters	Water	H_2O_2 (50%)	NaOH (5%)	Limewater
Days taken	*7 days*	*7 days*	*7 days*	*7 days*
Colour change	No change	White-brown	Creamy	White
Smell	Moderate	Moderate	Moderate	Slight
Damaging effect	Not detected	Not detected	Slight cracks	Not detected

Bones before cleaning | Plane water | H_2O_2 (50%) | NaOH (5%) | Limewater

Fig. 1:

Discussion

Most of the methods of bone preparation are tedious and time consuming. Also, they need training and expertise of persons doing these procedures. In present study, chemical preparation with Limewater (a clear liquid consisting of calcium hydroxide and water) with sunlight exposure in daytime for *7 days* was found to be the best method in terms of time required to complete the procedure, number of bones recovered; and colour and odour of the bones prepared. However, the chemical method has the disadvantage of dissolving and cracking the bones if the concentration used is high and prompt attention is not given to the preparation.[8]

Effectiveness of detergents for the purpose of soft-tissue removal from animal-derived specimens is comparable to enzymatic maceration but with fewer health and safety issues; and greater advantages regarding transportation and availability of materials when an investigator is in a fieldwork scenario.[9] Rennick *et al.* (2005) employed three cleaning techniques, boiling bone in water, in bleach, and in powdered detergent/sodium carbonate, to test for their effect on nuclear and mtDNA recovery from a variety of human and non-human bones. The human bones also showed much lower yields from bleach cleaning, while the detergent/carbonate method allowed the largest segments of DNA to be amplified, indicating it may have a less degradative effect on bone DNA than either of the other cleaning processes.[10]

Enzyme maceration has been shown to be remarkably fast compared to the traditional warm-water procedure, which requires up to several days. In addition, the enzyme maceration eliminates the odor problem associated with the traditional procedure. This method allows preparation of skeletal material in an essentially odorless way within a matter of hours, making the method useful in particular for forensic science, private conservation workshops and educational purposes. The mtDNA was intact and all PCR products could be identified to the right species without contamination, demonstrating that both the warm water maceration and the fast enzyme preparation method had not compromised the DNA.[11] Enzymatic maceration has been declared to be the fastest and bones obtained are quite clean, but the problem is the obnoxious smell that develops during the process and high cost of enzymes used.[11] Using biological washing powder/detergent is also an effective method and readily available, but it requires manual cleaning by scrubbing off the soft tissue or by boiling. This scrubbing process can be time consuming and also requires manpower. The success of any bone cleaning technique is determined by the time taken, the resources required, and the results obtained in relation to the intended purpose for which cleaning is required.[12]

Maceration is time consuming especially with larger animals and elicits strong odours. Insects are useful as a technique to clean bones because they perform an excellent debridement of smallest cavities but several thousand are required to produce rapid cleaning and if left with bones for a long period of time can eat and destroy them. Soft tissue removal by solutions of organic and inorganic chemicals was found to be the most effective since it macerates bone in a remarkably fast and odourless way. And it also has a less degradative effect on bone DNA than the other cleaning processes. But prompt attention should be given to the preparation when using the chemical method so that the concentration used is not high in order to avoid dissolving and cracking the bones.

So, the chemical preparation of bones specimens with Limewater in terms of comparatively easy procedure, less time required in procedure (*a week*), whitest colour of the bones and minimal odour during procedure etc. can be of enormous value for many institutes to get their self-prepared bone specimens. As it is essential to constantly reevaluate the methods of skeletal preparation to ensure a product that is acceptable visually as well to touch, we have found this method of bone preparation to be very useful and easy as compared to other methods of bone preparation.

Conclusion

Chemical preparation of bones with the Limewater (a clear liquid consisting of calcium hydroxide and water) with sunlight exposure in daytime for a week was found to be the best method in terms of time required to complete the procedure, colour of the bones and odour of the preparation. We also find a similar but little inferior result with H_2O_2. The chemical method has the disadvantage of dissolving and cracking the bones if the concentration used is high and prompt attention is not given to the preparation. In bone preparation with chemical method, the smell of the bones and the process is not difficult and distasteful as perceived in the other methods like burial or leaving bones open above ground. Time duration for chemical method is also too short comparatively.

Acknowledgement

Sincere gratitude and thankfulness to the paramedical staff, Department of Anatomy AIIMS, Raipur, Chhattisgarh. Our heartfelt thanks to the Body-donors and their families for their endeavor of serving society selflessly even after death by the noble and gracious act of Body-donation.

Ethical clearance

As study was performed on bones obtained from donated bodies after routine dissection part of undergraduate study and teaching, so there is no need of any ethical clearance from Institute Ethics Committee (IEC). Donated bodies are for study and research activities in any Medical Institute.

Conflicts of interests: None.

References

1. Modi BS, Puri N and Patnaik. Evaluation of techniques for cleaning embalmed cadavers' bones. International Journal of Anatomy and Research. 2014;2(4):810–13.
2. Boyle C. Maceration and preparation of mamma skeletons for long-term curation. Archaeology and forensic laboratory. University of Indianapolis, 2010.
3. Grygon. Tutorial cleaning of Bones Part 1. 2010. Available in: http://fav.me/d2lxlel
4. Eriksen AM, Simonsen KP and Rasmussen AR. Conservation of mitochondrial DNA in fast enzyme-macerated skeletal material. International Journal of Conservation Science. 2013;4(2):127–32.
5. Offele D, Harbeck M, Dobberstein RC, *et al.* Soft tissue removal by maceration and feeding of Dermestids sp: impact on morphological and biomolecular analyses of dental tissues in forensic medicine. International Journal of Legal Medicine. 2007;121(5):341–48.
6. Christensen AM and Myers SW. Macroscopic observations of the effects of varying fresh water pH on bone. Journal of forensic sciences. 2011;56(2):475–79.
7. Steadman DW, DiAntonio LL, Wilson JJ, *et al.* The effects of chemical and heat maceration techniques on the recovery of nuclear and mitochondrial DNA from bone. Journal of forensic sciences 2006;51(1):11–7.
8. Onwuama KT, Salami SO, Ali M, *et al.* Effect of different methods of bone preparation on the skeleton of the African giant pouched rat (cricetomys gambianus). International Journal of Morphology. 2012;30(2):425–27.
9. Mairs S, Swift B and Rutty GN. Detergent: An alternative approach to traditional bone cleaning methods for forensic practice. The American Journal of Forensic Medicine and Pathology. 2004;25(4):276–84.
10. Rennick SL, Fenton TW and Foran DR. The effects of skeletal preparation techniques on DNA from human and non-human bone. Journal of forensic sciences. 2005;50(5):1016–19.
11. Simonsen KP, Rasmussen AR, Mathisen P, *et al.* A fast preparation of skeletal materials using enzyme maceration. Journal of Forensic Sciences. 2011;56(2):480–84.
12. Fenton TW, Birkby WH, Cornelison J. A fast and safe non-bleaching method for skeletal preparation. J Forensic Sci. 2003;48:274–76.

Original Article

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Morphometric Study of Adult Dried Human Scapulae in South Indian Population

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Abstract

Background: Scapula is one of the important components of shoulder girdle. According to clinical experts several shoulder pathologies found to have an anatomical basis. The scapula is one of the bones found to present several variation based on race, sex, and region. Thus the osteometric measurements and morphometric knowledge of the scapula is essential to understand normal anatomy, for comparative anatomy, to treat different shoulder disorders and also for manufacturing of prosthetic products. *Aims and Objectives:* To obtain the baseline data of morphometric measurements of dry human scapula among South Indian Population. To compare the clinical importance of obtained parameters with anthropometric studies done by other authors. *Materials and Methods:* The following study was conducted on 105 dry adult human scapula obtained from the students of first MBBS. The measurements was taken using digital vernier calliper and obtained data was statistically analysed using student '*t*' test using SPSS version 20. *Results and Conclusion:* The anthropometric measurements of the adult dry human scapula among South Indian Population are reported in this paper. This data could be of helpful for surgeons, anthropologists to understand the normal anatomy of scapula which play an important role in the management of different shoulder pathologies, rehabilitation of shoulder injuries, contribute to demographic studies, and also assist in forensic cases.

Keywords: Shoulder; Scapula; Girdle; Morphometric; Injury.

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Introduction

The Human Scapula is one of the bones of shoulder girdle. It is a flat bone, triangular in shape and is situated in the posteriolateral part of chest wall overlapping the second to seventh ribs. The Scapula presents 2 surfaces-costal and dorsal, 3 borders-lateral, medial and superior, 3 angles-lateral, inferior and superior,and 3 processes-spine, acromian and coracoid. Lateral angle bears the glenoid cavity and represents head of the scapula and rest represents the body of the scapula. The body has subscapular fossa on its costal surface and supraspinous and infraspinous fossa on its dorsal aspect with triangular spine in between which continues as acromion process laterally. The superior border continues laterally as coracoid process. The coracoacromial arch is formed by the coracoid and acromial processes connected by the ligament.Various muscles attached to the Scapula act on the gleno-humeral joint, stabilises and also brings about various movements at that joint.[1]

The morphometry of the acromion process of the scapula is an important factor implicated in impingement syndrome of the shoulder joint.[2] The phylogenic, ontogenic and racial variations of the scapula make it as one of the most interesting bones for research. Also the dimensions of the scapula are of major importance in the patho-mechanics of rotator

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cuff disease, total shoulder arthroplasty, recurrent shoulder dislocation, for comparative anatomy, for surgical procedures and for manufacturing prosthetics.[3] The aim and objectives of the present study was to record the morphometrical data of the scapula among the South Indian population and to compare the results obtained from the present study with previous studies done in different populations which helps to establish possible morphofunctional correlations related to race, geographic region and literature data.

Materials and Methods

The present study includes 105 dried adult human scapulae of unknown age and sex obtained from the Department of anatomy, Kodagu Institute of Medical Sciences, Madikeri. 51 scapulae were from left side and 54 were from right side. Deformed, damaged and paediatric scapulae was excluded from the study. The following measurements were taken using digital vernier callipers of 0.1 mm precision and the mean and standard deviation were calculated and tabulated. The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 20. The morphometric values of the two sides were analysed using a Student *t*-test. Statistical significance was set $p \leq 0.05$ (**Figs.1 and 2**).

Scapular length (AB): The distance from the superior angle to the inferior angle of scapula.

Scapular width (CD): The maximum transverse diameter between the medial border of the scapula, where the spine meets the body of the scapula, and the anterior lip of the glenoid.

Acromion length (EF): The distance between tip and midpoint of posterior border of acromion process.

Acromion breadth (GH): The distance between the lateral and medial borders at the midpoint of the acromion process.

Projection length of scapular spine (IJ): The distance from the medial edge of the scapula to the lateral edge of the acromion process.

Superior-Inferior glenoid diameter (KL): The maximum distance measured from the inferior point on the glenoid margin to the most prominent point of the supraglenoid tubercle.

Anterior-Posterior glenoid diameter (MN): The maximum breadth of the articular margin of the glenoid cavity perpendicular to the glenoid cavity height.

Length of the coracoid process (OP): The distance from the base to the tip of the coracoid process.

Acromio-Coracoid distance (QR): The distance between the tip of acromion and tip of the coracoid processes.

Acromio-Glenoidal distance (QS): The distance between tip of acromion process and supraglenoid tubercle.

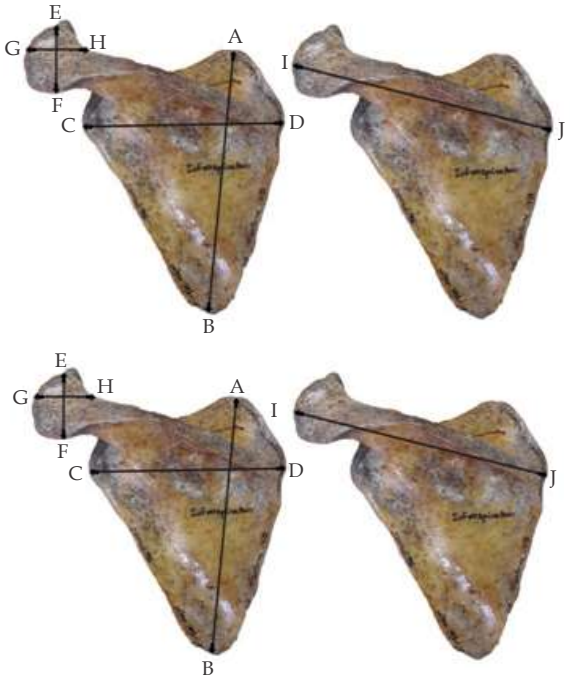

Fig. 1: AB: Scapular length; CD: Scapular width; EF: Acromion length; GH: Acromion breadth; IJ: Projection length of scapular spine.

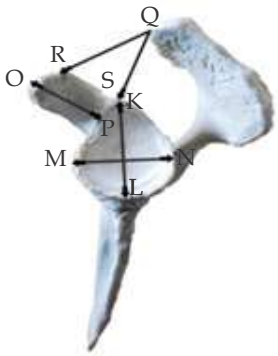

Fig. 2: KL: Superior-Inferior glenoid diameter; MN: Anterior-Posterior glenoid diameter; OP: Length of the coracoid process; QR: Acromio-Coracoid distance; (QS): Acromio-Glenoidal distance.

Results

The maximum length of scapula in the present study ranged from 109 –176 *mm* on the left side and

107–160 *mm* on the right with mean value of 138.9–139.6 *mm* and standard deviation of 11.4–12.4 *mm* respectively. The maximum width of the scapula in the present study ranged from 77 *mm*–113 *mm* on the left side and 84–114 *mm* on the right with mean value of 96.6–99.2 *mm* and standard deviation of 7.7–7.7 *mm* respectively which was statistically insignificant (**Table 1**).

The Mean and Standard deviation of superior inferior diameter and anterioposterior diameter of glenoid cavity was 36.1 ± 3.6 *mm* and 23.2 ± 2.5 *mm* on left side and 35.6 ± 2.9 *mm* and 20.3 ± 4.5 *mm* on right scapula respectively.

The length and breadth of Acromian process ranged between 13–44 *mm* and 17–28 *mm* with Mean and Standard deviation of 33.4 ± 5.9 *mm* and 22.8 ± 2.5 *mm* on left side and ranged between 27 and 57 *mm* and 11–30 *mm* with Mean and Standard deviation of 42.8 ± 6.6 *mm* and 23.3 ± 3.1 *mm* on right side respectively.

The Length of the coracoid process ranged between 28–50 *mm* and 31–49 *mm* with Mean and Standard deviation of 38.4 ± 4.4 *mm* and 39.1 ± 4.3 *mm* on left and right side respectively.

The Mean and Standard deviation of Projection length of scapular spine was 129.1 ± 8.8 *mm* and 129.3 ± 10.3 *mm* on left and right side respectively.

The Acromio-Coracoid distance and Acromio-Glenoidal distance was 37.3 ± 6.4 *mm* and 26.4 ± 4.4 *mm* on left and 41.6 ± 6.7 *mm* and 23.5 ± 4.1 *mm* on right respectively.

Table 1: Scapular measurements.

Sl. no.	Scapular measurements	Mean ± SD (*mm*)		Range (*mm*)	
		Left	Right	Left	Right
1	Scapular length	138.9 ± 11.4	139.6 ± 12.4	109–176	107–160
2	Scapular width	96.6 ± 7.7	99.2 ± 7.7	77–113	84–114
3	Superior-Inferior glenoid diameter	36.1 ± 3.6	35.6 ± 2.9	31–54	29–41
4	Anterior-Posterior glenoid diameter	23.2 ± 2.5	20.3 ± 4.5	17–30	11–28
5	Acromion length	33.4 ± 5.9	42.8 ± 6.6	13–44	27– 57
6	Acromion breadth	22.8 ± 2.5	23.3 ± 3.1	17–28	11–30
7	Length of the coracoid process	38.4 ± 4.4	39.1 ± 4.3	28–50	3– 49
8	Projection length of scapular spine	129.1 ± 8.8	129.3 ± 10.3	111–144	108–148
9	Acromio-Coracoid distance	37.3 ± 6.4	41.6 ± 6.7	21–52	28–60
10	Acromio-Glenoidal distance	26.4 ± 4.4	23.5 ± 4.1	16–35	15–36

Discussion

Each individual presents with variations in shoulder anatomy, overall conditioning and fitness and degrees of shoulder laxity that makes the precise evaluation of pathologic lesions difficult. Even though the variation in the morphology of Scapula are few, its anthropometric measurements have great importance in understanding the shoulder girdle pathologies and also useful in treating the various disorders of shoulder joint and also in designing shoulder implants.[4]

The Scapular length in the present study is lower when compared with the other studies (**Table 2**). whereas the scapular width is similar with the studies conducted by Lingamdenne PE *et al*.[6] Wael amin *et al*.[3] has reported higher scapular length and width of 151.20 ± 9.47 *mm* and 107.01 ± 9.00 *mm* on left side and 151.05 ± 8.42 *mm* and 107.43 ± 8.07 *mm* on right side in Egyptian population. Manju

Table 2: Comparison of Scapular length and width.

Sl. no.	Authors	Scapular length Mean ± SD (*mm*)		Scapular width Mean ± SD (*mm*)	
		Left	Right	Left	Right
1	**Jaskaran singh *et al*.[5] (2013)**	145 ± 11.3	144.6 ± 12.2	106.5 ± 7.5	104.6 ± 7.7
2	**Wael Amin *et al*.[3] (2015)**	151.20 ± 9.47	151.05 ± 8.42	107.01 ± 9.00	107.43 ± 8.07
3	**Lingamdenne PE[6] (2016)**	141.5 ± 9.7		98.6 ± 6.9	
4	**Manju Madhavan *et al*.[4] (2017)**	132.4 ± 11.05	130.1 ± 10.9	89.7 ± 8.8	90.9 ± 6.2
5	**Present study (2018)**	138.9 ± 11.4	139.6 ± 12.4	96.6 ± 7.7	99.2 ± 7.7

Madhavan *et al.*[4] has reported lower scapular width in South Indian population. These different values could be due to racial, ethnic, and regional variations. This data can be used for demographic studies, comparative studies among different population groups and forensic cases.

The superior inferior diameter of glenoid cavity in the present study showed near values with the study conducted by Lingamdenne PE *et al.*[6] who reported the values of 36.85 ± 3.17 *mm* irrespective of side of the scapula. Ajay M Parmar *et al.*[7] reported the higher values of 37.46 ± 2.92 *mm* on left and 37.31 ± 2.91 *mm* right side and Manju Madhavan *et al.*[4] in their study recorded the lower values of 34.92 ± 2.14 *mm* on left and 36.92 ± 1.81 *mm* on right side than that of the present study.

Anterior-Posterior glenoid diameter as reported by Manju Madhavan *et al.*[4] was 22.19 ± 1.52 *mm* on left and 23.91 ± 2.91 *mm* on right side and Ajay M Parmar[7] recorded 25.9 ± 2.09 *mm* on left and 25.7 ± 2.32 *mm* on right side. Lingamdenne PE *et al.*[6] reported 25.07 ± 2.55 *mm* irrespective of the side of scapula. However, Mamatha T *et al.*[8] in their study showed lower values of 19.6 *mm* on left and 20.1 *mm* on right respectively. The anteriosuperior diameter of glenoid cavity in the present study is lower on right side than left side whereas its contradictory to the results made by the other authors compared in having higher values on right side than on the left scapula.

Wael amin *et al.*[3] reported higher superior inferior and anterioposterior glenoid diameter of 39.01 ± 2.49 *mm* and 27.99 ± 2.55 *mm* on left side and 38.88 ± 2.63 *mm* and 28.31± 2.38 *mm* on right side scapula respectively. They also reported higher values of superior inferior glenoid diameter on left than right which is similar to the present study but contradictory to the results of other authors compared.

The precise knowledge of the glenoid anatomy is necessary to treat the glenoid fractures, rotator cuff tears, bony Bankarts lesion.[6] When the glenoid notch is distinct, the glenoid labrum is often not attached to the rim of the glenoid at the site of the notch and can be a predisposing factor in anterior dislocation of the shoulder joint.[3]

The length and breadth of the acromion is of paramount importance in the management of rotator cuff tears and impingement syndrome.[6] The results are compared with previous authors (**Table 3**). Wael Amin *et al.*[3] reported higher dimensions in the Acromian process and the present study showed lower values than than the other studies compared.

The undersurface of the anterior one third of the acromion was pinpointed by Neer CS as the area

Table 3: Comparison of Morphometric measurements of Acromian process with the previous studies.

Sl. no.	Authors	Length of Acromian process Mean ± SD (*mm*)		Breadth of Acromian process Mean ± SD (*mm*)	
		Left	Right	Left	Right
1	**Jaskaran Singh** *et al.*[5]	45.8 ± 5.3	46.4 ± 5.2	23 ± 2.4	23.4 ± 2.7
2	**Wael Amin** *et al.*[3]	53.28 ± 4.1	52.33 ± 4.2	32.01 ± 3.7	32.09 ± 3.2
3	**Lingamdenne PE**[6]	43.22 ± 5.7		24.64 ± 2.9	
4	**Manju Madhavan** *et al.*[4]	42 ± 5.2	42.1 ± 4.1	24.9 ± 2.9	27.3 ± 3.8
5	**Present study**	33.4 ± 5.9	42.8 ± 6.6	22.8 ± 2.5	23.3 ± 3.1

responsible for impinging upon the components of the rotator cuff (especially the supraspinatus tendon). He noted a characteristic ridge of spurs (enthesophytes) on the anterior acromion process. The relationship of acromial morphology to the clinical syndrome of shoulder impingement was an important precursor to rotator cuff tears in 95% of Neer's cases.[2]

Lingamdenne PE *et al.*[6] reported the coracoid length as 39.04 ± 4.16 *mm*, slightly higher to our finding of 38.82 ± 4.16 *mm* and the projection length of scapular spine as 123.35 *mm* which was lower than the present study which showed 129.23 *mm* irrespective of side of Scapula. It is important to have the knowledge of coracoid length while planning for a coracoid osteotomy in the management of coracoid impingement syndrome.

Acromiocoracoid distance and acromioglenoid distance in the present study showed 37.3 *mm* and 26.4 *mm* on left side and 41.6 *mm* and 23.5 *mm* on right side respectively. The results are compared with previous studies (**Table 4**). Acromiocoracoid distance showed higher right side values in the present study which was statistically significant ($p = 0.0011$) and also showed slightly higher values than the study done by the previous authors. The

Table 4: Comparison of Acromiocoracoid distance and Acromioglenoid distance with previous studies.

Sl. no.	Authors	Acromiocoracoid distance Mean ± SD (*mm*)		Acromioglenoid distance Mean ± SD (*mm*)	
		Left	Right	Left	Right
1	**Mansur** *et al.*[2]	39.39 ± 5.32	39.03 ± 6.2	31.97 ± 3.96	31.83 ± 3.66
2	**Wael Amin** *et al.*[3]	31.10 ± 3.55	31.58 ± 3.09	27.11 ± 3.08	27.67 ± 3
3	**Lingamdenne PE** *et al.*[6]	31.85 ± 4.4		24.46 ± 3.68	
4	**Ritu** *et al.*[9]	37.96	29.86		
5	**Present study**	37.3 ± 6.4	41.6 ± 6.7	26.4 ± 4.4	23.5 ± 4.1

acromio coracoid and acromio-glenoid distances have a significant role in rotator cuff lesions, and impingement syndromes that affect the shoulder and also play an important role in their management.[6]

Racial and sexual differences can interfere in the development of bone projections, providing alterations such as size and morphology. These alterations can occur in scapulae and may affect the glenohumeral stability.[3]

Conclusion

The purpose of the present study was to record the basic morphometric values of the Scapulae in South Indian population which helps the medical practitioners to understand, treat the different shoulder joint disorders, and help in designing implants for the shoulder joint. It can also be used for demographic studies, assist in forensic cases, and rehabilitation of players who sustained sports injuries.

References

1. Dutta AK. Essentials of Human Anatomy Part III 4th edition. Current Books International; 2009.pp.5–9.
2. Mansur DI, Khanal K, Haque MK, *et al.* Morphometry of Acromion Process of Human Scapulae and its Clinical Importance amongst Nepalese Population. Kathmandu Univ Med J. 2012;38(2):33–6.
3. Wael Amin NE, Mona HMA. A Morphometric Study of the Patterns and Variations of the Acromion and Glenoid Cavity of the Scapulae in Egyptian Population. Journal of Clinical and Diagnostic Research. 2015;9(8):AC08–AC11.
4. Susan Varghese, Manju Madhavan Chandramathi Amma. Morphometric study of dry human scapulae. J Evolution Med Dent Sci. 2017;6(75):5365–71.
5. Singh J, Pahuja K, Agarwal R. Morphometric parameters of the acromion process in adult human scapulae. Indian Journal of Basic and Applied Medical Research. 2013;2(8):1165–1170.
6. Lingamdenne PE, Marapaka P. Measurement and analysis of anthropometric measurements of the human scapula in telangana Region, India**.** International Journal of Anatomy and Research. 2016; 4(3):2677–83.
7. Parmar AM, Vaghela B, Shah KP, *et al.* Study of glenoid cavity of human scapula and its clinical Importance. International Journal of Anatomy and Research. 2017;5(3.2):4177–81.
8. Mamatha T, Pai SR, Murlimanju BV, *et al.* Morphometry of glenoid cavity. Online J Health Allied Scs. 2011;10(3):7.
9. Singroha R, Verma U, Malik P, Rathee SK, *et al.* Morphometric study of acromion process in scapula of North Indian population. International Journal of Research in Medical Sciences. 2017 Nov;5(11):4965-69.

Original Article

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Correlation of Hand Dimensions with Foot Dimensions: A Central Indian Study

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Abstract

Background and Objectives: Forensic investigation necessitates estimation of age, sex, stature and weight of human individual. Researchers all over the world studied various human parts in different ways. Both halves of human body are fairly symmetrical. It is assumed that each body part is having some relation with other part. Present study was conducted with the aim to study the relationship between hand and foot dimensions. *Methodology:* This cross-sectional study was conducted amongst 1000 participants (500 male and 500 female) of ESIC Institute Gulbarga over a period of 14 months. Hand and foot dimensions were measured. *Results:* Significant correlation was observed between hand and foot dimensions in both sexes and on both sides. Correlation co-efficient 'r' and Linear regression equation was calculated. *Interpretation and Conclusion:* Statistically significant correlation was observed between hand and foot dimensions of both side sin both sexes. This data would be useful for forensic investigations and anthropometric studies.

Keywords: Correlation; Hand Length; Hand Breadth; Foot Length; Foot Breadth; Linear Regression Coefficient; Crime.

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Introduction

Forensic investigation necessitates estimation of age, sex, stature and weight of human individual. Researchers all over the world have studied various human parts in different ways. It is assumed that each body part is having some relation with other part. Relationships of hand length and foot length with various body part measurements have been studied by authors like Anitha Oommen *et al.*[1] (2005), Prakash M Mohite *at al.*[2] (2015), Chikhalkar BG *et al.*[3] (2008) in Indian population. Crime has increased in Central part of India over the last two decades. Hand and foot impressions are one of the commonest evidence left at crime site from which stature, age, sex, weight of the suspect has to be correlated. Previous studies conducted on similar topicin our region have not yielded significant results. Hence, statistically significant database regarding correlation of hand and foot dimensions are not available for the population of this region. Hence this study was proposed over a large sample size with multiple variables being studied with an aim to develop a reliable database useful for forensic investigation, anthropometric studies.

Aim

To study the relationship of hand dimensions with foot dimensions.

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Materials and Methods

***Study design*:** Descriptive cross sectional study.

***Setting*:** Anthropometric section of Department of Anatomy, ESIC Institute Gulbarga, Karnataka.

***Duration of study*:** 14 months; From 31st October, 2017–31st December 2018.

***Sample size*:** 1000 which includes Medical, Dental and Nursing students aged between 17 and 20 years of age in ESIC Institute Gulbarga.

Sampling technique: *Inclusion criteria*: Medical, Dental and Nursing students aged between 17 and 20 years in ESIC Institute Gulbarga.

Exclusion criteria: Students of NRI quota and students those with poorly defined wrist creases, deformities of vertebral column and limbs, contractures, missing limbs, history of trauma to hand and foot, with features suggestive of dysmorphic syndromes, chronic illness, hormonal therapy were excluded from the study.

***Sample selection*:**

Simple random sampling method[4] as 1000 participants were selected out of total 3000 Medical, Dental and Nursing students of ESIC Institute Gulbarga satisfying the inclusion criteria. Participants belonged to 1st to 3rd year as they were easily accessible and represented the young adult age group.

Data collection procedure

Hand Length: Each subject was made to place his/her hand on a white paper with the palm facing upwards keeping the fingers close together with the thumb lying comfortably but not tightly against the radial aspect of the hand and index finger (**Fig. 1**). A tracing of the hand was made with a lead pencil. The tracing proceeded from the radial styloid process to the ulnar styloid process. A line designated as the inter-styloid line was drawn joining the two styloid tips. Hand length (L) was measured using a Vernier Slide Calipers as the distance between the distal crease of wrist to tip of middle finger.[2]

Fig 1: Measurement of hand length

Hand Breadth: Measured from 1st metacarpo-phalangeal joint to base of 5th metacarpal in *cm* using Vernier Caliper[2] (**Fig 2**).

Fig 2: Measurement of hand breadth

Foot Length: Each subject will stand on a Calibrated Foot Board with his/her back against the wall in such a manner that the posterior most point of the heel will gently touch the wall. A vertical stop was placed against the anterior most point of the foot. The distance between the posterior most point of the heel and the anterior most point of the foot was measured as the foot length (Anitha Oommen *et al.*,[1] 2005) (**Fig. 3**).

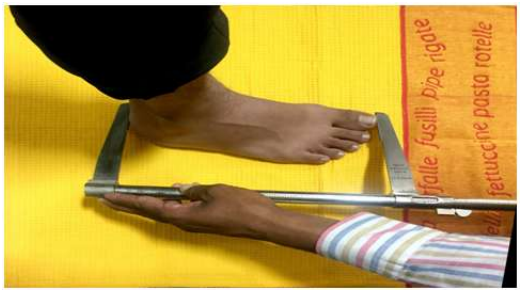


Fig 3: Measurement of foot length

Foot Breadth: It will be measured as distance between Metatarsal tibiale (point projecting most medially on the head of the 1st metatarsal bone) and Metatarsal Fibulare (point projecting most laterally on the head of the 5th metatarsal bone) (Rati Tandon *et al.*,[5] 2016) (**Fig. 4**).

Fig 4: Measurement of foot breadth

Data collection tools: Vernier slide calipers, calibrated foot board, stadiometer, regular weight machine, questionnaire for collection of personal details, academic scores, lead pencils, stationary etc. Data collected was tabulated, statistically analyzed and graphically represented.

Results and Discussion

Foot length on right side in male ranged from 22.6 *cm*–28.9 *cm* with **mean of 25.18 *cm*** and SD of 1.32. Foot length on left side in male ranged from 22.8 *cm* –29.0 *cm* with **mean of 25.31 *cm*** and SD of 1.15, **Table 1**.

These findings correspond with studies of Anitha Oommenet *et al.*[1], Rati Tandon *et al.*[5], Patel SM, Shah GV *et al.*[9] 2007, Prakash M Mohite *et al.*[2] (2015). Shown in **Table 9**.

Foot length on right side in female ranged from 21.0 *cm* –25.7 *cm* with **mean of 23.39 *cm*** and SD of 1.19. Foot length on left side in female ranged from 21.5 *cm*–25.4 *cm* with **mean of 23.19 *cm*** and SD of 0.97, **Table 2**.

These findings correspond with studies of Anitha Oommenet *et al.*[1], Rati Tandon *et al.*[5], Patel SM, Shah GV *et al.*[9] 2007, Prakash M Mohite *et al.*[2] (2015). Shown in **Table 9**.

Table 1: Correlation of Hand length and Foot length in male (right**).**

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation-*r*	*p*-value
Hand length right	16.5	23.8	7.3	18.9	1.16	500	$r = 0.536$	$p < 0.01$ HS
Foot length right	22.6	28.9	6.3	25.18	1.32	500		
Linear Regression Equation	Hand length right in males = 8.602 + 0.409 (Foot length right)							

Table 2: Correlation of Hand length and Foot length in male (left).

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation-*r*	*p*-value
Hand length left	16.5	24.6	8.1	18.96	1.27	500	$r = 0.446$	$p < 0.01$ HS
Foot length left	22.8	29.0	6.2	25.31	1.16	500		
Linear Regression Equation	Hand length left in males = 6.558 + 0.49 (Foot length left)							

Foot breadth on right side in male ranged from 7.8 *cm*–10.9 *cm* with **mean of 9.39 *cm*** and SD of 0.70. Foot breadth on left side ranged from 7.8 *cm* – 11.5 *cm* with **mean of 9.35 *cm*** and SD of 0.59, **Table 3**.

These findings correspond with studies of B Danborno, A Elukpoet *et al.*[6] (2007), Rati Tandon *et al.*,[7] Patel PN, Tanna JA *et al.*[8] (2012), Chikhalkar BG *et al.*[3] (2008). Shown in **Table 9**.

Foot breadth on right side in female ranged from 7.5 *cm*–9.8 *cm* with **mean of 8.45 *cm*** and SD of 0.52. Foot breadth on left side ranged from 7.7 *cm*–9.8 *cm* with **mean of 8.53 *cm*** and SD of 0.48, **Table 4**.

These findings correspond with studies of B Danborno, A Elukpoet *et al.*[6] (2007), Rati Tandon *et al.*[5], Patel PN, Tanna JA *et al.*[8] (2012), Chikhalkar BG *et al.*[3] (2008). Shown in **Table 9**.

Hand length on right side ranged from 13.9 *cm*–23.8 *cm* with **mean of 18.11 *cm*** and SD of 1.38. Hand length on left side ranged from 13.9 *cm*–24.6 *cm* with **mean of 18.10 *cm*** and SD of 1.47. These findings correspond closely with those of Oommenet *et al.*[1], Chikhalkar *et al.*[3] and Kavyashree *et al.*[10], (**Table 9**).

Hand Breadth on Right side ranged from 7.6 *cm*–19.0 *cm* with **mean of 9.91 *cm*** and SD of 0.76. Hand Breadth on left side ranged from 7.6 *cm*–19.0 *cm* with **mean of 9.83 *cm*** and SD of 0.77, (**Table 9**). These findings were higher than those observed in almost all the previous studies (**Table 4**). This is might because in present study, hand breadth was measured from 1st metacarpo-phalangeal joint to

Table 3: Correlation of Hand length and Foot length in female (right).

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation-*r*	*p*-value
Hand length right	13.9	19.7	5.8	17.18	0.99	500	$r = 0.132$	$P < 0.05$ S
Foot length right	21.0	25.7	4.7	23.39	1.19	500		
Linear Regression Equation	Hand length right in females = 15.15 + 0.051 (Foot length right)							

Table 4: Correlation of Hand length and Foot length in female (left).

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation-*r*	*p*-value
Hand length left	13.9	19.7	5.8	17.11	0.99	500	$r = 0.138$	$p < 0.05$ S
Foot length left	21.5	25.4	3.9	23.19	0.96	500		
Linear Regression Equation	Hand length left in females = 14.21 + 0.063 (Foot length left)							

base of 5th metacarpal; whereas in previous studies it was measured from 2nd metacarpo-phalangeal joint to base of 5th metacarpal. Hand breadth observations matched with Prakash M. Mohite *et al*.[2]

Linear regression co-efficient has been calculated for different combinations of body parts. Observations have been shown in (**Tables 1–8** also **Graphs 1–8).**

Table 5: Correlation of Hand breadth and Foot breadth in male (right).

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation-*r*	*p*-value
Hand breadth right	8.8	19.0	10.2	10.36	0.68	500	$r = 0.240$	$p < 0.01$ S
Foot breadth right	7.8	10.9	3.1	9.39	0.71	500		
Linear Regression Equation	Hand breadth right in males = 8.175 + 0.22 (Foot breadth right)							

Table 6: Correlation of Hand breadth and Foot breadth in male (left).

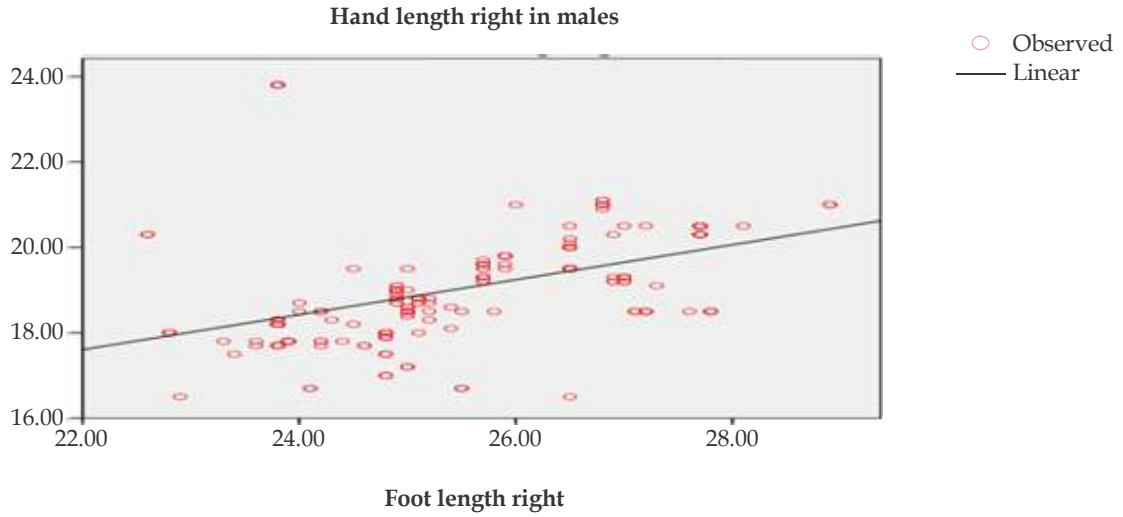
Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation-*r*	*p*-value
Hand breadth left	8.9	19	10.1	10.29	0.69	500	$r = 0.206$	$p < 0.01$ HS
Foot breadth left	7.8	11.5	3.7	9.35	0.59	500		
Linear Regression Equation	Hand breadth left in males = 8.252 + 0.219 (Foot breadth left)							

Table 7: Correlation of Hand breadth and Foot breadth in female (right).

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation-*r*	*p*-value
Hand breadth right	7.6	10.6	2.3	9.39	0.47	500	$r = 0.182$	$p < 0.01$ HS
Foot breadth right	7.5	9.8	2.3	8.45	0.52	500		
Linear Regression Equation	Hand breadth right in females = 8.09 + 0.154 (Foot breadth right)							

Table 8: Correlation of Hand breadth and Foot breadth in female (left).

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation-*r*	*p*-value
Hand breadth left	7.6	10.6	2.4	9.31	0.47	500	$r = 0.164$	$p < 0.01$ HS
Foot breadth left	7.7	9.8	2.1	8.52	0.47	500		
Linear Regression Equation	Hand breadth left in females = 8.023 + 0.152 (Foot breadth left)							

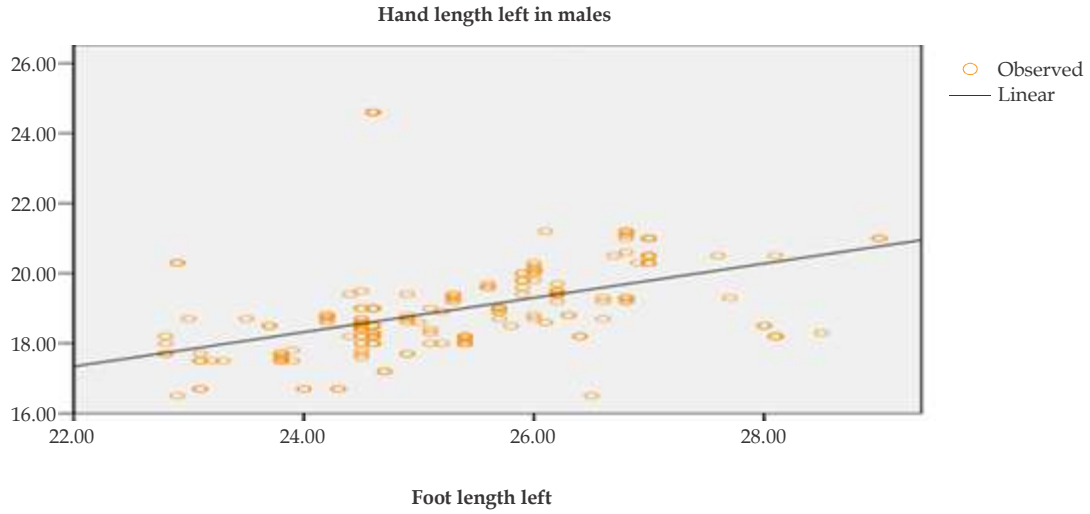


Graph 1: ROC curve of hand length v/s Foot length of right in males

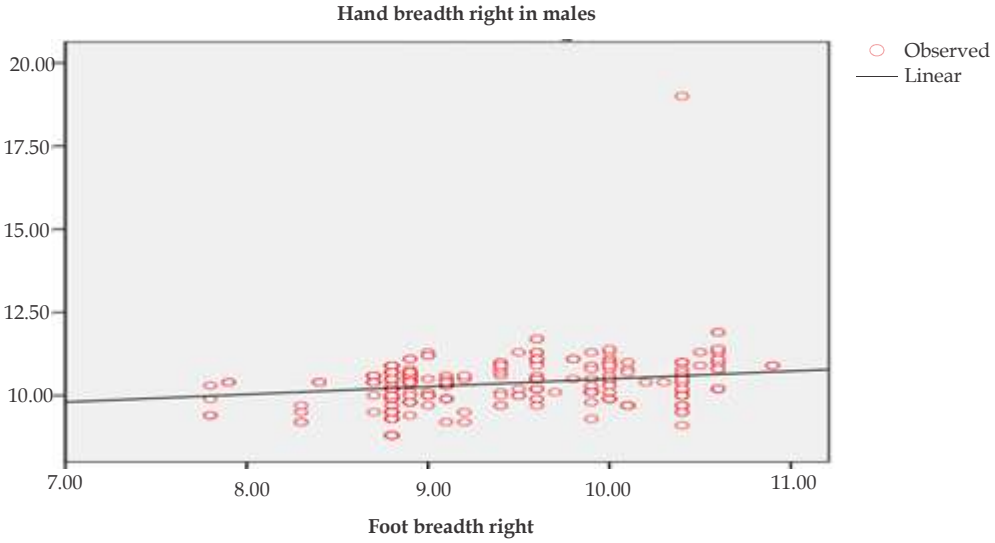
Table 9: Comparison of present study with previous studies.

Sl. no.	Study/Author/ Year	Variable studied	Sample size	Observations							
				Mean hand length		Mean hand breadth		Mean foot length		Mean foot breadth	
				Right M/F	Left M/F	Right M/F	Left M/F	Right M/F	Left M/F	Right M/F	Left M/F
1	Anitha Oommen *et al.*[1] (2005)	HL, FL	100	19.06/17.32	19.06/17.24	NM	NM	26.21/ 23.75	26.0/23.68	NM	NM
2	B Danborno, A Elukpo *et al.*[6] (2007)	H, HL, HB, FL, FB	400	19.85/18.51	19.93/18.52	8.90/7.82	8.68/7.72	28.39/24.52	26.42/24.70	9.02 / 8.23	9.09/8.11
3	Patel SM, Shah GV *et al.*[7] *2007*	H, FL	502	NM	NM	NM	NM	Male 24.44	Female 22.34	NM	NM
4	Chikhalkar BG *et al.*[3] (2008)	H, FAL, HL, HB, FL, FB	300	18.9		7.53		24.008 with SD 1.420		8.895 with SD 0.703	
5	Patel PN, Tanna JA *et al.*[8] (2012)	H, FL, FB, HL, HB, AS	273	17.758 with SD1.2517		7.917 with SD 0.7926		24.178 with SD 1.809		9.28 with SD 0.865	
6	A. Ibegbu, David *et al.*[9] (2013)	H, HL	600 children	NC	NC	NC	NC	NC	NC	NC	NC
7	Prakash M. Mohite *et al.*[2] (2015)	H, HL, HB, FL	230	Male -19.11, Female -17.4		Male -8.64, female -7.37		Male - 25.86, Female - 22.67		NM	NM
8	Kavyashree AN *et al.*[10] (2015)	H, HL, HB	294	SM- right -18.81, left-18.74 NM-right-18.95, left-18.70 SF-right -17.17, Left-17.21 SM-right-17.30, left-17.31		SM- right -8.24, left-8.00 NM-right-8.24, left-8.10 SF-right -7.24, Left-7.19 SM-right-7.26, left-7.22		NM	NM	NM	NM
9	Rati Tandon *et al.*[5] (2016)	H, HL, HB, FL, FB, DL	497	Male -19.364, Female -17.33		Male-8.312, female-7.247		Male-6.22, Female-3.35		Male-9.95, female - 8.89	
10	Nataraja Moorthy T and Hairunnisa BMAK *et al.*[11] 2017)	W,FL,FB	200	NM	NM	NM	NM	25.25/23.05	25.26/23.05	NM	NM
11	Present study[12] (2018–19)	H, HL,HB, FL, FB	1000	18.90/17.18	18.96/17.11	10.3/9.9	10.29/9.31	25.18/23.39	**25.31/23.1**	**9.39/8.45**	**9.35/8.52**

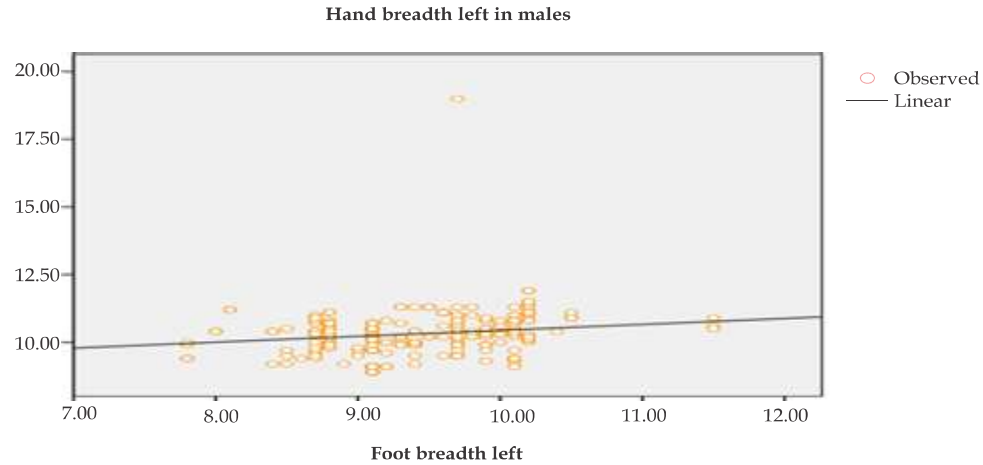
H - Height, **HL -** Hand length, **HB -** Hand breadth, **FL -** Foot length, **FB -** Foot breadth, **PL -** Palm length, **DL -** Digit/finger length, **AS -** Arm span, **FAL -** Forearm length, **NM -** Not measured, **NC -** Not comparable, **NA -** Not available.



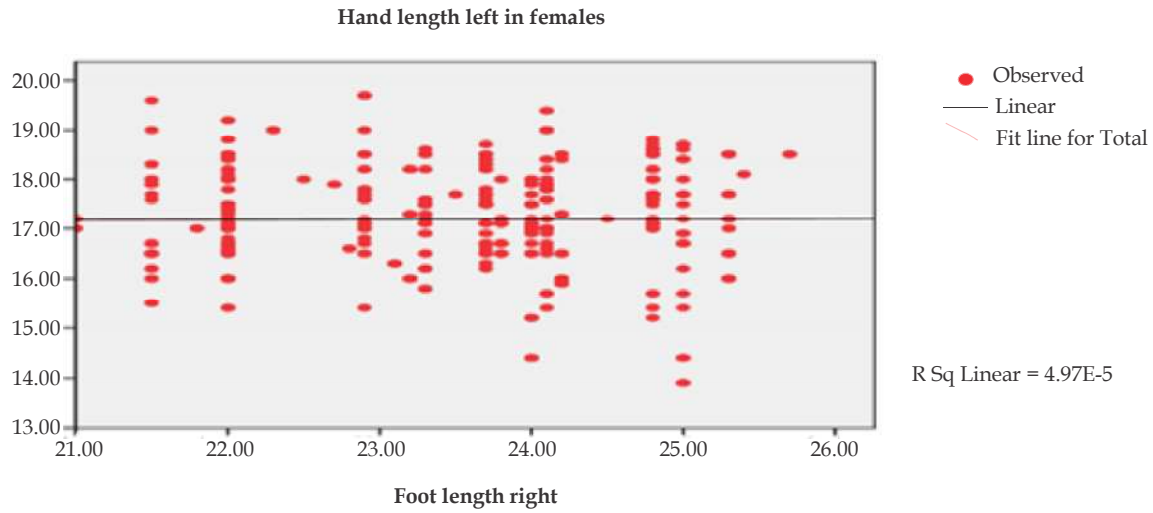
Graph 2: ROC curve of hand length v/s Foot length of left in males



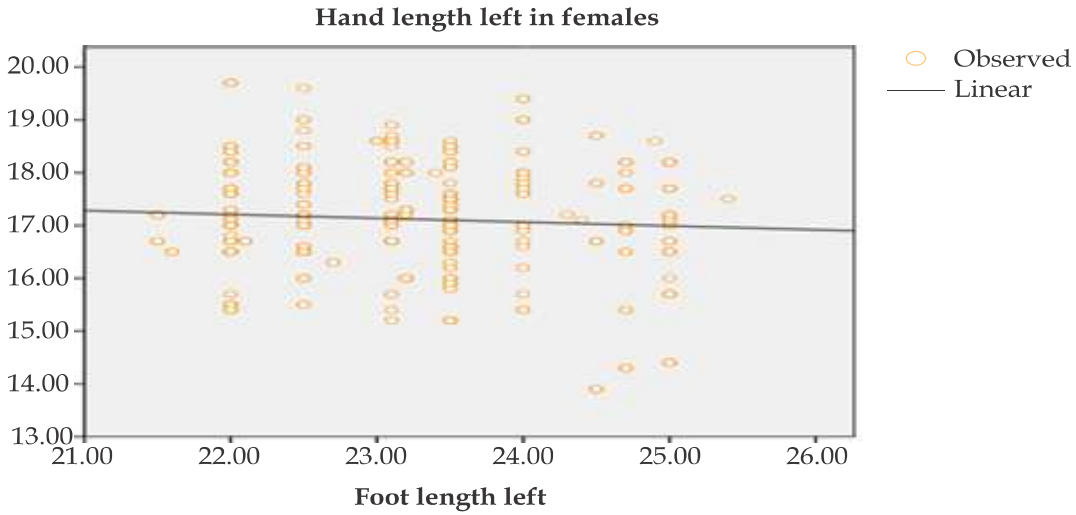
Graph 3: ROC curve of hand breadth v/s Foot breadth of right in males



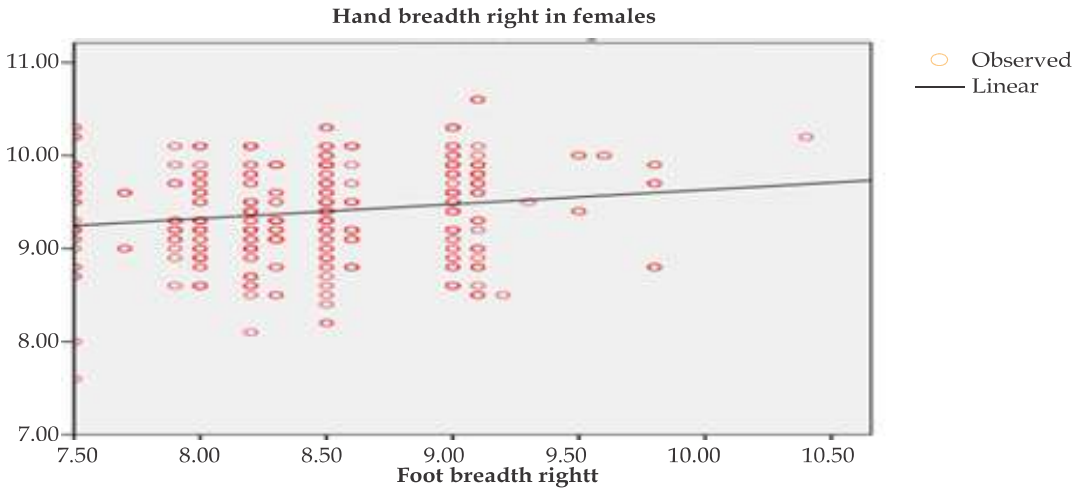
Graph 4: ROC curve of hand breadth v/s Foot breadth of left in males



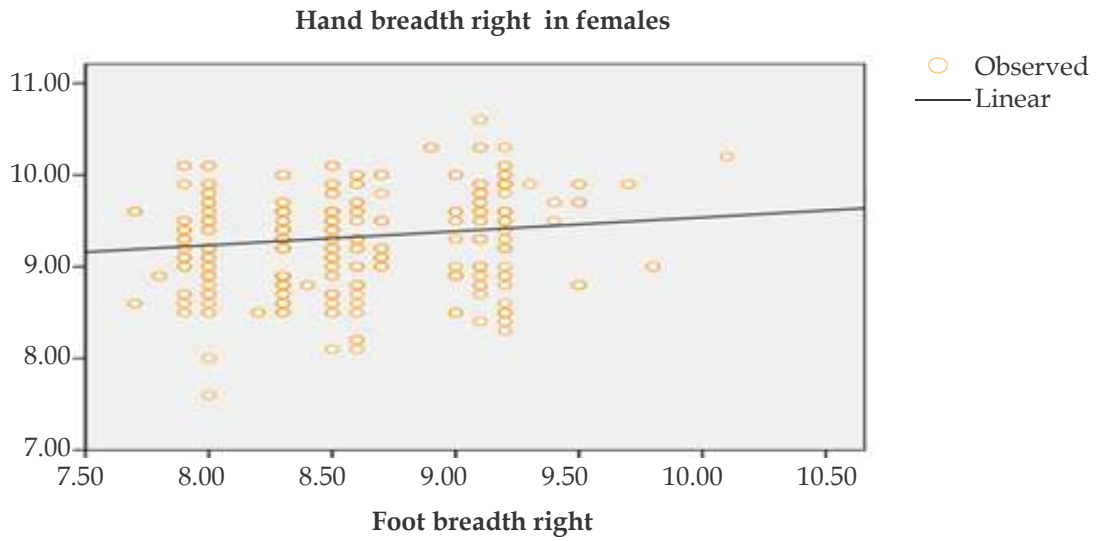
Graph 5: ROC curve of hand length v/s Foot length of right in females



Graph 6: ROC curve of hand length v/s Foot length of left in females



Graph 7: ROC curve of hand breadth v/s Foot breadth of right in females



Graph 8: ROC curve of hand breadth v/s Foot breadth of left in females

Conclusions

1. Highly statistically significant difference was observed in mean foot length and breadth on both sides in both sexes.
2. Statistically significant correlation was observed between hand length and foot length in both sexes.
3. Statistically significant correlation was observed between hand breadth and foot breadth in both sexes.
4. The linear regression formula derived can be used for population between 17 and 20 years but it might be of limited use for children and older people.
5. Equation derived from present study can be used to estimate hand dimensions from foot dimensions and *vice versa* among the Central Indian population.
6. It would be unwise to use the same equations for estimation of hand and foot dimensions for different Indian populations.

Limitations

1. In the present study, age range of only *17–20 years* was considered.
2. Only healthy individuals were included in the study. Hence the data may not be applicable students those with deformities of foot, vertebral column and limbs, contractures, those with h/o of trauma to foot, those with features suggestive of dysmorphic disorder, pregnant females.
3. Applicability of anthropometric measurements in living and deceased individuals may practically differ.
4. The present study is a preliminary one and would be followed up by other studies to address the above limitations.

Conflict of Interest: None.

References

1. Anitha O. A Study of the correlation between hand length and foot length in humans. J Anat Soc India. 2005;54(2)55–7.
2. Prakash M Mohite. Correlation of the dimensions of hand and feet with stature of an individual: A study on Central Indian Adults. J Indian Acad. Forensic Med. April–June 2015;37:(2)160–64.
3. Chikhalkar BG, Mangaonkar AA, Nanandkar SD, *et al.*. Estimation of stature from measurements of long bones, hand and foot dimensions. J Indian Acad Forensic Med. 2009;32(4):329–30.
4. Kothari CR, Gaurav Garg. Research methodology: Methods and techniques, 3rd edition 2014. Reprint 2016. p14.
5. Rati Tandon. Measurements of hand and foot: A predictor of stature in Adult Human Population of Uttar Pradesh. International Journal of Anatomy, Radiology and Surger. 2016 Jan;5(1)12–5.

6. Danborno B, Elukpo A. sexual dimorphism in hand and foot length, indices, stature-ratio and relationship to height in Nigerians. The Internet Journal of Forensic Science. 2007;3(1):1–5.
7. Patel SM, Shah GV, Patel SV. Estimation of height from measurements of foot length in Gujarat Region. J Anatomy Soc, India. 2007;56(1):25–7.
8. Patel PN, Tanna JA, Kalele SD. Correlation between hand length and various anthropometric parameters. International Journal of Medical Toxicology and Forensic Medicine. 2012;2(2):61–3.
9. Ibegbu AO, David ET, Hamman WO, *et al.* Association of and length with height in Nigerian School Children. Journal of Biology and Life Science. 2013;4(2):83–4.
10. Kavyashree AN. Stature determination from hand dimensions. Journal of International Medicine and Dentistry 2015;2(3):209–14.
11. Nataraja Moorthy T, Hairunnisa MAK. Determination of living body weight from foot outline length measurements among Lun Bawangs of East Malaysia. Indian J Forensic Med Tox. 2017;11:278–82.
12. Charmode SH, Kadlimatti HS, Pujari D. Correlation of human stature with hand dimensions: A study in Young Population of Central India International Journal of Human Anatomy. 1(3):36–4.

Original Article

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Estimation of Human Height from Hand Dimensions: A South Indian Study

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Abstract

Background and Objectives: Identification of sex, age, race and stature is the most important aspect of any forensic investigation.There is a strong correlation of stature with hand dimensions and if either of the measurements is known, the other can be calculated. With this objective, the present study was designed to correlate the hand dimensions with stature of an individual and to record the standard deviation in the estimation of stature. *Methodology:* This cross-sectional study was conducted amongst 1000 participants (500 Male and 500 Female) of ESIC Institute Gulbarga over a period of 14 months. Hand dimensions along with stature and weight were measured. Linear regression co-efficient was calculated. *Results:* Mean stature was 161.88 *cm*. Mean hand length was 18.11 *cm* on right side and 18.10 *cm* on left side. Mean hand breadth was 9.91 *cm* on right side and 9.83 *cm* on left side. *Conclusion:* Highly significant difference in right and left side mean hand length and breadth measurements was observed. Also observed was a strong positive statistically significant correlation between height and hand dimensions. This data might be useful for forensic, epidemiological and anthropometric studies where stature determination is of utmost importance.

Keywords: Dimensions; Human stature; Hand length; Hand breadth; Correlation.

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Introduction

There are many studies undertaken to emphasize the importance of measuring the hand dimensions to estimate stature. The hand dimensions, being genetically derived varies in different races and ethnic groups and is used to determine sex, age, stature and nutritional status of an individual. Identification of sex, age, race and stature is the most important aspect of investigations in cases of mass disasters like Bomb explosions, public vehicle (plane, railway, bus, truck, car) accidents, cross border terrorist attacks, natural calamities, murders where bodies or isolated extremities are found in disintegrated, mutilated and skeletonized state.[1–2] Hand dimensions have been found to have a correlation with the stature of an individual. In Central India, a few studies have been conducted in past on the same subject but achieved insignificant findings due to various factors. Over all crime and accidents have grown in this region in last couple of decades. The present study was thus proposed to study hand dimensions in relation to stature and weight of an individual over a large sample size with the objective to provide statistically significant data for forensic department in this region for accurate estimation of stature from hand dimensions.

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Materials and Methods

Study design: Descriptive cross-sectional study.

Setting: Anthropometric section of Department of Anatomy, ESIC Medical College and Hospital, Gulbarga, Karnataka.

Duration of study: 14 months from 31st October, 2017 to 31th December, 2018.

Sample size: 1000 participants, (500 Male, 500 Female) which includes Medical, Dental and Nursing students aged between 17 and 20 years of age in ESIC Medical College, Gulbarga.

Sampling technique:

Inclusion criteria: Medical, Dental and Nursing students aged between 17 and 20 years in ESIC Medical College, Gulbarga.

Exclusion criteria: Students of NRI quota, students those with poorly defined wrist creases, deformities of vertebral column and limbs, contractures, missing limbs, history of trauma to hand and foot, with features suggestive of dysmorphic syndromes, chronic illness, hormonal therapy were excluded from the study.[3–4]

Sample selection:

Simple random sampling method[5] was used to select 1000 participants (500 Male, 500 Female) from our Medical, Dental and Nursing students (Total 3000) after satisfying the inclusion criteria. Students were easily accessible and also represented the young adult age group.

Data collection procedure: After receiving the Ethical Committee approval of Institutional Ethical Committee, the data collection procedure was started after taking informed consent. Tutors and junior residents took the measurements after training. Measurements were taken thrice and average was taken. Diurnal variation was avoided by taking the measurements between 1 and 2 pm only daily. Hand dimensions have been measured in different way in different studies but we followed the method adopted by study of Mohite *et al*.[6] in Central Indian population. The measurements were taken as follows:

Hand Length: Each subject was made to place his/her hand on a white paper with the palm facing upwards keeping the fingers close together with the thumb lying comfortably but not tightly against the radial aspect of the hand and index finger (**Figs. 1–2**). A tracing of the hand was made with a lead pencil. The tracing proceeded from the radial styloid process to the ulnar styloid process. A line designated as the inter-styloid line was drawn joining the two styloid tips. Hand length (L) was measured using a Vernier Slide Calipers as the

Fig 1: Measurement of Hand Length

Fig 2: Measurement of Hand Breadth

distance between the distal crease of wrist to tip of middle finger.[6]

Hand Breadth: Measured from 1st metacarpo-phalangeal joint to base of 5th metacarpal in *cm* using Vernier Caliper.[6]

Height: Measured to the nearest centimeters (*cm*) using a Stadiometer with subject standing erect on a horizontal resting plane bare footed having the palms of the hands turned inward and the finger pointing downwards (**Fig. 3**). The height was measured from the sole of the feet to the vertex of the head as recommended by International Biological Program.[7]

Data collection tools: Vernier slide calipers, Calibrated foot board, Stadiometer, Regular weight machine, Questionnaire for collection of personal details, Academic scores, Lead pencils, Stationary etc.

Data collected were tabulated, graphically represented and statistically analyzed.

Fig 3: Measurement of Human Stature

Results

Table 1 shows statistically highly significant positive correlation between Height and Hand length of right and left ($p < 0.01$). Study reveals that hand length of both sides was also significantly more in those having more stature. Through the linear regression equation **Height = 75.31 + 4.782* Hand length (right) and Height = 75.26 + 4.786* Hand length (left)** we are able to estimate height by the known value of hand length.

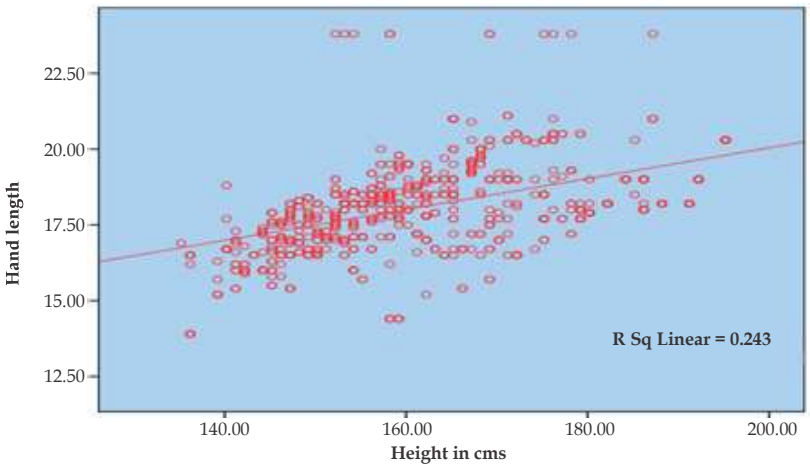
There was a highly statistically significant positive correlation between height and hand breadth of right and left ($p < 0.01$). The study revealed that hand breadth of both sides was also significantly more in those having more stature. There was a linear regression equation **Height = 63.186 + 4.782 *Hand breadth (right) and Height = 68.798 + 4.786* Hand breadth (left)** (**Graphs 1–2**).

There was statistically very highly significant difference inhand length (right and left), hand breadth (right and left),Height andweight between males and females ($p < 0.001$) (**Table 3**). The hand length (right and left), hand breadth (right and left), height and weightwere significantly more in Males as compare Females (**Graph 3**).

Table 1: Correlation of hand length and stature

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation r	P value
Height (cm)	135.2	195.2	60.0	161.88	13.45	1000	--	--
Hand length right (cm)	13.9	23.8	9.9	18.11	1.38	1000	r = 0.493	P<0.01 HS
Hand length left (cm)	13.9	24.6	10.7	18.10	1.47	1000	r =0.524	P<0.01 HS
Linear Regression Equation	Height = 75.31 + (4.782 * Hand length (right))							
Linear Regression Equation	Height = 75.26 + (4.786 *Hand length (left))							

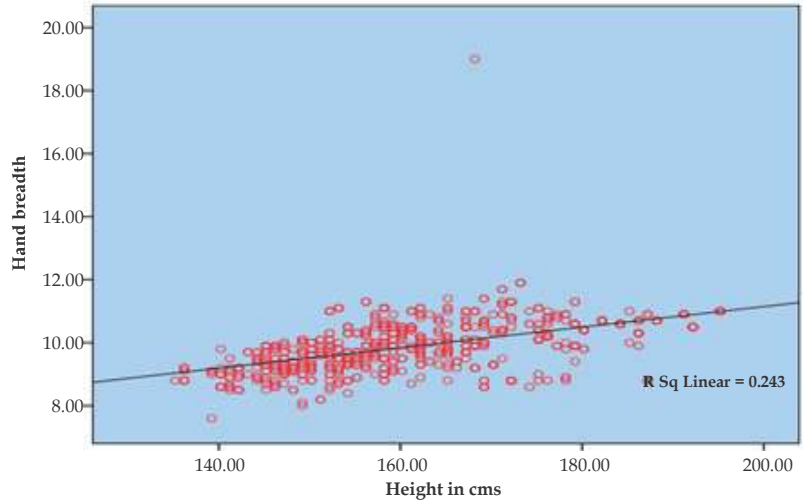
NS= not significant, S=significant, HS=highly significant, VHS=very highly significant



Graph 1: Correlation between Hand length and Stature

Table 2: Correlation of Hand Breadth and stature

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation r	P value
Height (cm)	135.2	195.2	60.0	161.88	13.45	1000	–	–
Hand breadth right (cm)	7.6	19.0	11.4	9.91	0.76	1000	r = 0.569	P<0.01 HS
Hand breadth left (cm)	7.6	19.0	11.4	9.83	0.77	1000	r = 0.547	P<0.01 HS
Linear Regression Equation	Height = 63.186 + 4.782 * Hand breadth (right)							
Linear Regression Equation	Height = 68.798 + 4.786 * Hand breadth (left)							

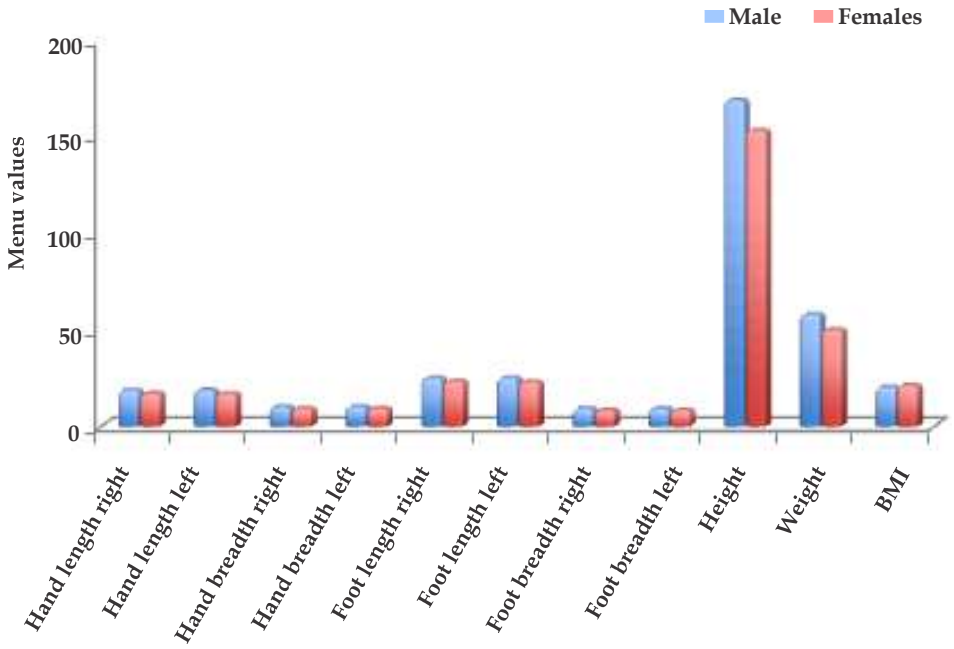


Graph 2: Correlation between Hand Breadth and Stature

Table 3: Gender wise comparison of parameters

Variables	Male (N=500) Mean ± SD	Female(N=500) Mean ± SD	Z test value	P value and significance
Hand length right	18.90 ± 1.16	17.18 ± 0.99	Z = 24.48	P<0.001, VHS
Hand length left	18.96 ± 1.27	17.11 ± 0.99	Z = 24.79	P<0.001, VHS
Hand breadth right	10.36 ± 0.68	9.39 ± 0.47	Z = 25.02	P<0.001, VHS
Hand breadth left	10.29 ± 0.69	9.31 ± 0.47	Z = 21.56	P<0.001, VHS
Height	169.28 ± 11.75	153.42 ± 9.75	Z = 22.26	P<0.001, VHS

NS= not significant, S=significant, HS=highly significant, VHS=very highly significant



Graph 3: Multiple bar diagram represents gender wise comparison of variables

Discussion

In present study, human stature ranged from 135.2 *cm* to 195.2 *cm*. mean stature was 161.88 *cm* with SD of 13.45. These findings correspond closely with studies done on Indian population like that of Patel *et al.*[2] and Mohite *et al.*[6] and Chikhalkar *et al.*[11].

Hand length on right side ranged from 13.9 *cm* to 23.8 *cm* with mean of 18.11 cm and SD of 1.38. Hand length on left side ranged from 13.9 *cm* to 24.6 *cm* with mean of 18.10 *cm* and SD of 1.47. These findings correspond closely with those of Oommen *et al.*,[8], Shankar *et al.*,[10] Chikhalkar *et al.*[11] and Kavyashree *et al.*,[12] (**Table 1**).

Hand Breadth on Right side ranged from 7.6 *cm* to 19.0 *cm* with mean of 9.91 *cm* and SD of 0.76. Hand Breadth on left side ranged from 7.6 *cm* to 19.0 *cm* with mean of 9.83 *cm* and SD of 0.77, (**Table 2**). These findings were higher than those observed in almost all the previous studies (**Table 4**). This is might because in present study, hand breadth was measured from 1st metacarpo-phalangeal joint to base of 5th metacarpal; whereas in previous studies it was measured from 2nd metacarpo-phalangeal joint to base of 5th metacarpal. Hand breadth observations matched with Mohite *et al.*[6]

Gender related comparison of hand dimensions was done and found them to be significantly more in males as compared to females. These findings matched findings from almost all previous studies as mentioned in **Table 4**.

Correlation co-efficient '*r*' calculated for hand length (right: r = 0.493, left: r = 0.524) and hand breadth (right: r = 0.569, left: r = 0.547) correspondswith that calculated in studies of Chikhalkar *et al.*[11] (hand length r = 0.5902, hand breadth r = 0.6004); Patel *et al.*[2] (hand length r = 0.806, hand breadth r = 0.467); Pal *et al.*[17] (HL r = 0.683, HB r = 0.53), Tandon *et al.*[9] (Male, HL r = 0.224, HB r = 0.154; Female, HL r = 0.313, HB r = 0.272), Patel *et al.*[2] (hand length r = 0.806, hand breadth r = 0.467). A strong correlation was observed in present study between human height and hand length and breadth similar to findings of Rastogi *et al.*[3]

Linear Regression Equation calculated in the present study corresponds with that calculated in previous studies like Tandon *et al.*[9] (regression formulae for male, female and complete samples were: $y = 5.79x + 124.54$; $y = 7.125x + 105.5$ and, $y = 11.36x + 76.49$ respectively); Shankar *et al.*[10] (male: y = 7.96 + (0.061* right hand length), female: y = 10.49 + (0.04* left hand length); Mohite *et al.*[6] (2015) (h = 65.60 + (0.54* head length), h = 104.03 + (0.76* head breadth); Patel *et al.*[2] (y = 59.52 + 5.9163* HL, y = 121.69 + 5.4188* HB).

Table 4: Comparison of present study with previous studies

No.	Study / Author	Year	Sample size (n)	Parameters studied	Observations				
					Mean height (*cm*)	Mean hand length (*cm*)		Mean hand breadth (*cm*)	
						Right M/F	Left M/F	Right M/F	Left M/F
1	Oommen *et al*[8]	2005	100	HL, FL	NA	19.06 / 17.32	19.06 / 17.24	NM	NM
2	Danborno and Elukpo[1]	2007	400	H, HL, HB, FL, FB	173.7 /160.0	19.8 / 18.5	19.9 / 18.5	8.9 / 7.8	8.6 / 7.7
3	Patel *et al*.[13]	2007	502	H, FL	170.9 / 156.14	NM	NM	NM	NM
4	Rastogi *et al*.[3]	2008	500	HL, HB, H	NA	NA	NA	NA	NA
5	Chikhalkar *et al*.[11]	2009	300	H, W, FAL, HL, HB, FL, FB	167.26	18.93	18.93	7.53	7.53
6	Krishan, *et al*.[14]	2011	246	HL, HB, FL,FB	NA	NA	NA	NA	NA
7	Patel, *et al*.[2]	2012	273	H, FL, FB, HL, HB, AS	164.59	17.75	NM	7.91	NM
8	Ibegbu, *et al*.[7]	2013	600 children	H, HL	NC	NC	NC	NC	NC
9	Mohite, *et al*.[6]	2015	230	H, HL, HB, FL	165.02	171.13*	NM	68.04	NM
10	Bodorikova and Nescakova[15]	2015	250	H, HL, HB, FL, FB	NA	NA	NA	NA	NA
11	Kavyashree *et al*.[12]	2015	294	H, HL, HB	NM	18.81	18.74	8.24	8.00
12	Dey and Kapoor[16]	2015	147	HL, HB	NM	19.2 / 17.3	19.0 / 16.5	8.3 / 7.57	8.18/7.45
13	Pal, *et al*.[17]	2016	1662 women	HL, HB, W, H, DL	NM	16.3	16.31	7.05	7.03
14	Tandon *et al*.[9]	2016	497	H, HL, HB, FL, FB, DL	172.7 / 157.1	19.3 / 17.3	NM	8.3 / 7.2	NM
15	Shankar *et al*.[10]	2017	220	H, HL	NM	18.21 / 18.81	18.35 / 18.82	NM	NM
16	Kim, *et al*.[18]	2018	5195	H, HL, HB, FL, FB	NM	NM	NM	NM	NM
17	Samoon *et al*.[19]	2018	158	HL, H	NM	NM	NM	NM	NM
18	Ibrahim *et al*.[20]	2018	350	S, HL, PL, HB, FL	175.44/158.96	20.11/18.65	20.75/18.6	8.76/7.66	8.7/7.62
19	Present study	2019	1000	H, HL, HB	161.88	18.90 / 17.18	18.96 / 17.11	10.36/9.39	10.29 / 9.31

H- Height, HL – Hand length, HB – Hand breadth, FL – Foot length, FB – Foot breadth, PL – Palm length, DL – Digit / finger length, AS-Arm span, FAL – Forearm length, NM – Not measured NC - Not comparable, NA – Data not available.

Conclusion

Highly significant difference was observed in mean hand length and breadth on both sides.

Positive statistically significant correlation was observed between height and hand dimensions.

The linear regression formula derived can be used for adult between 17 and 20 years but it might be of limited use for children and older people for measuring the stature and shoe design.

The stature of an individual can be calculated from either of the dimension of hand, *i.e.* length or breadth and *vice versa*.

This data might be useful for forensic, epidemiological and anthropometric studies.

Limitations

In the present study, age range of only 17 to 20 years was considered.

Only healthy individuals were included in the study. Hence the data may not be applicable students those with poorly defined wrist creases, deformities of vertebral column and limbs, contractures, those with h/o of trauma to hand and foot, those with features suggestive of dysmorphic disorder.

Applicability of anthropometric measurements in living and deceased individuals may practically differ. The present study is a preliminary one and would be followed up by other studies to address the above limitations.

Conflict of Interest: The authors declared that they have no conflict of interest.

Funding of study: Self funded study.

References

1. Danborno B, Elukpo A. Sexual dimorphism in hand and foot length, indices, stature-ratio and relationship to height in Nigerians. The Internet Journal of Forensic Science. 2007;3(1):1–5.
2. Patel PN, Tanna JA, Kalele SD. Correlation between hand length and various anthropometric parameters. International Journal of Medical Toxicology and Forensic Medicine. 2012;2(2):61–3.
3. Rastogi P, Nagesh KR, Yoganarasimha K. Estimation of stature from hand dimensions of North and South Indians. Legal Medicine. 2008; 10(4):185–89.
4. Keshavachandran CN, Bihari V, Mathur N. The normal range of body mass index with high body fat percentage among male residents of Lucknow City in North India. Indian J Med Res. 2012;135(1):72–7.
5. Kothari CR, Garg G. Research Methodology: Methods and Techniques, 3rd edition 2014; Reprint 2016. p. 4.
6. Mohite PM, Keche AS, Mohite DP, *et al.* Correlation of the dimensions of hand and feet with stature of an individual: A study on Central Indian Adults. J Indian Acad. Forensic Med. 2015;37(2):160–64.
7. Ibegbu AO, David ET, Hamman WO, *et al.* Association of hand length with height in Nigerian School Children. Journal of Biology and Life Science. 2013;4(2):83–94.
8. Oommen A, Mainker A, Oommen T. A study of the correlation between hand length and foot length in humans. J Anat Soc, India 2005;54(2):55–7.
9. Tandon R, Yunus SM, Faruqi NA, *et al.* Measurements of hand and foot: A predictor of stature in adult Human Population of Uttar Pradesh. International Journal of Anatomy, Radiology and Surgery. 2016;5(1):12–5.
10. Shankar GS, Shankar VV, Radhika K, *et al.* Correlation of human height with hand length in Indian individuals. Int J Anat Res. 2017;5(4.1): 4478–481.
11. Chikhalkar BG, Mangaonkar AA, Nanandkar SD, *et al*. Estimation of stature from measurements of long bones, hand and foot dimensions. J Indian Acad Forensic Med. 2009;32(4):329–30.
12. Kavyashree AN, Bindurani MK, Asha KR. Determination of stature from hand dimensions in Indian Population. Journal of International Medicine and Dentistry. 2015;2(3):209–14.
13. Patel SM, Shah GV, Patel SV. Estimation of height from measurements of foot length in Gujarat Region. J Anatomy Soc India. 2007;56(1): 25–7.
14. Krishan K, Kanchan T, Sharma A. Sex determination from hand and foot dimensions in a North Indian Population. J Forensic Sci. 2011;56(2):45–9.
15. Bodorikova S, Nescakova E. Estimation of stature using hand and foot dimensions in Slovak adults. J Forensic Leg Med, (Tokyo). 2015;17(2):92–7.
16. Dey S, Kapoor AK. Hand length and hand breadth: A study of correlation statistics among Human Population. International Journal of Science and Research. 2015;4(4):148–50.
17. Pal A, De S, Sengupta P, *et al.* Estimation of stature from hand dimensions in Bengalee Population, West Bengal, India. Egyptian Journal of Forensic Sciences. 2016;6:90–98.
18. Kim W, Kim YM, Yun MH. Estimation of stature from hand and foot dimensions in a Korean Population. J Forensic Leg Med. 2018;55:87–92.
19. Samoon S, Itoo MS, Shahdad S, *et al.* Correlation of stature and hand length in Adult Kashmiri Population. International Journal of Contemporary Medical Research. 2018;5(3):C1–C2.
20. Ibrahim MA, Khalifa AM, Hassan HA, *et al.* Estimation of stature from hand dimensions in North Saudi Population, medicolegal view. Saudi J Forensic Med Sci. 2018;1:19–27.

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The Anatomy of Accessory Obturator Nerve in Human Cadavers

Kusum R Gandhi[1], Nisha Yadav[2]

Abstract

Background: Standard anatomy textbooks describe accessory obturator nerve (AON) as small arising from ventral branches of third and fourth lumbar ventral rami. It descends along medial border of psoas major, the accessory nerve emerges from the medial border of the psoas muscle and travels parallel but 2–3 *cm* ventrolateral to the main nerve. It reaches the thigh by crossing the superior pubic ramus behind the pectineus muscle and then divides into several branches. One branch directly innervates the pectineus, another joins the anterior division of the obturator nerve, and a third conveys sensory input from the hip joint. AON is still under recognized and its presence has great clinical consequences for lumbar plexus blockade. The presence of the AON leads to incomplete anesthesia during obturator nerve block, thus unable to achieve painless hip joint surgeries. The AON may also contribute to continued adductor spasm despite ON blockade. Misidentification of the nerve can also lead to injury. *Objective:* Looking to the applied anatomy of AON and its anatomical variability, we planned to study the detailed anatomy of AON in human cadavers. *Methods:* Permission from the Institutional Ethical Committee was obtained before starting the project. We have carried out thorough dissection of lumbar plexus in forty-six cadavers bilaterally. Only one male cadaver had a large retroperitoneal mass distorting the anatomy of concerned region on right side, was excluded from the study. The fibers of psoas major were then meticulously dissected at their origin from the lateral surface of the lumbar vertebra and the accessory obturator nerve was traced till its roots at the intervertebral foramen. The course and branches of AON was carefully recorded. *Results:* AON was observed in 29 of 91 cases (31%) of cases. Most commonly the AON was forming from the ventral rami of L3 and L4 but in cases AON was taking origin from the trunk of obturator nerve. The branching pattern of AON was variable: AON was connected to obturator nerve in 20 (21%), to anterior branch in 30 (31%) and to posterior branch in 4 (5%) of cases in present study. Pectineus muscle was solely supplied by AON in 13 (14%) specimens. *Conclusion:* The presence of AON is clinically important as it is also considered during ON blockade. The AON blockade can be indicated in superficial surgeries of thigh, treatment of pain due to thigh tourniquet, as a diagnostic aid for pain syndromes in the hip joint, inguinal areas or lumbar spine, and in relief of intractable hip pain due to osteoarthritis. These anatomical details of AON will help anesthetists, orthopedic surgeons, neurophysicians to perform safe and uncomplicated procedures.

Keywords: Accessory obturator nerve; Obturator nerve block; Branches; Anesthetic; Orthopedic surgeon.

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Introduction

The accessory obturator nerve (AON) was first described in 1672 by Isbrand van Diemerbroeck.[1] He reported that it was found in roughly one out of every three persons and originated from the third and fourth lumbar nerves.[1] *Since* its discovery, it has been called the anterior internal crural nerve, accessory nerve of the internal crural nerve, and the nerve of the coxo-femoral articulation.[2] Some have proposed that it should be named the accessory femoral nerve owing to its typical derivation from the posterior part of the anterior division of L3 and L4, its function, and its anatomical course over the pubic ramus.[3]

Standard anatomy textbooks describe AON as

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small arising from ventral branches of third and fourth lumbar ventral rami. It descends along medial border of psoas major, the accessory nerve emerges from the medial border of the psoas muscle and travels parallel but 2–3 *cm* ventrolateral to the main nerve. It reaches the thigh by crossing the superior pubic ramus behind the pectineus muscle and then divides into several branches. One branch directly innervates the pectineus, another joins the anterior division of the obturator nerve, and a third conveys sensory input from the hip joint.[4–5]

AON is still under recognized and its presence has great clinical consequences for lumbar plexus blockade. The presence of the AON leads to incomplete anesthesia during obturator nerve block, thus unable to achieve painless hip joint surgeries. The AON may also contribute to continued adductor spasm despite ON blockade.[6] Misidentification of the nerve can also lead to injury.[5] Looking to this applied anatomy of AON, we planned to study the detailed anatomy of AON in human cadavers.

Materials and Methods

Permission from the Institutional Ethical Committee was obtained before starting the project. The cadaver populations belonging to age group *30 to 84 years*, of Asian origin were included in the study. In the supine position, forty-six cadavers (91 sides) underwent an anterior approach to the retroperitoneal space. Adult human cadavers (38 Males and 8 Female), embalmed in neutral formalin, were dissected bilaterally. After routine dissection of abdominal cavity by medical graduates, the specimens were used in the study. There were no signs of surgery, wound scars or trauma in the abdominal lumbar region of any of the cadavers included in the present study. Specimen having any pathology distorting the shape of kidney or renal pelvis was excluded from the study. One male cadaver having a large retroperitoneal mass distorting the anatomy of concerned region on right side, was excluded from the study.

Following the removal of abdominal viscera and peritoneum, the lumbar plexus was exposed by an anterior approach. The branches were identified as they pierced the anterior, medial and lateral borders of the psoas major muscle. The fibers of psoas major were then meticulously dissected at their origin from the lateral surface of the lumbar vertebra and the accessory obturator nerve was traced till its roots at the intervertebral foramen. The course and branches of AON was carefully recorded.

Results

AON was observed in 29 of 91 cases (31%) of cases. The mode of formation and branches of AON are

Table1: Formation of the accessory Obturator Nerve and its prevalence.

Sl. No.	Root value	Number of cases observed	Percentage (%)
1.	L2–L4	23	21.60%
2.	L3–L4	51	57%
3.	L2–L3	10	9%
4.	L3	12	11%
5.	Trunk of obturator nerve	2	2%

Table 2: Reported pattern of terminal branches of the accessory Obturator Nerve.

Sl. No.	Terminal branches	Prevalence	Percentage (%)
1.	Anastomosing with obturator nerve and supplying skin on inner thigh	8	10%
2.	Supplying Adductor longus by additional branch	2	3%
3.	Pectineus muscle sole innervation	13	14%
4.	Pectineus muscle duel innervation (femoral)	6	7%
5. (a)	Connects with obturator nerve	20	21%
(b)	Trunk of obturator nerve	8	9%
(c)	Anterior branch of the obturator nerve 14.30%	30	31%
(d)	Posterior branch of the obturator nerve	4	5%

described in **Table 1 and 2** respectively.

Origin

The formation of accessory obturator nerve was found variable as arising from L2 to L4, L3 to L4, L2 to L3 and L3 only and from the trunk of obturator nerve (**Table 1**). Most commonly AON was formed from the ventral rami of L3 to L4 but in cases AON was taking origin from the trunk of obturator nerve. The percentage of findings as shown in **Table 1**. Many variations are found in branching pattern

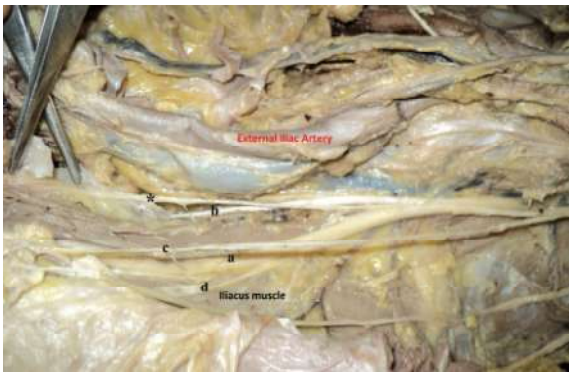

Fig 1: Left Lumbar plexus is shown with Left Accessory obturator nerve taking origin from L3–L4 is shown with Astrix (*). All the other branches of lumbar plexus are shown as femoral nerve (a), obturator nerve (b), genitofemoral nerve (c) and lateral femoral cutaneous nerve of thigh (d). The image is also published in our manuscript in the Journal of Anatomical Society of India 2013 (62) 47–51.

of AON in present study. The branches of AON are shown in **Table 2** along with some interesting findings.

Discussion

The results of the present cadaveric study clearly demonstrate that the branching pattern of the accessory obturator nerve is highly variable. Anatomic variability of the accessory obturator nerve may explain some of the difficulties experienced when locating and blocking the obturator nerve. Prevalence of an AON in humans has reported an incidence of 30%, which is in line with our findings. Other authors have reported an incidence range of 8% to 30% (**Table 3**).[7]

Akkaya *et al*. reported that the presence of an AON could negatively affect the clinical efficacy of an obturator nerve block. He stated that if the patient has an AON, it could be necessary to block this as well while obturator nerve blocks. AON blockage can be recommended for thigh surgeries, treatment of pain, and diagnosis of hip joint pain.[6]

Jirsch JD and Colin H. Chalk reported an interesting case of a 38-year-old woman who developed obturator mononeuropathy during elective laparoscopic tubal ligation, presumably due to accidental electrocauterization of the nerve along the lateral wall of the lesser pelvis. Compared to open pelvic surgery, laparoscopic techniques offer a more limited field of exposure and may hinder the identification of neural structures. Lying relatively deep in the pelvis, the obturator nerve may be particularly vulnerable

Table 3: Analysis of previous studies reporting the prevalence of the accessory Obturator Nerve.

Sl. No.	Author	Country	Year of study	Total number of specimens	Percentage observed
1.	Eisler		1892	120	29%
2.	Bardeen		1901	250	8.4%
3.	Kaiser		1949	24	8.3%
4.	Woodburne	Michigan	1960	550	8.7%
5.	Katritsis		1980	1000	13.2%
6.	Akkaya	Turkey	1999	24	12.5%
7.	Anloague and Hijibregt	Dayton, OH	2009	30	8.8%
8.	Turgut *et al.*	Turkey	2017	40	30%
9.	Present study	India	2018	91	31%

to misidentification and subsequent injury. This problem may be compounded by the presence of an accessory obturator nerve, an anatomical variant that is common yet under recognized, judging from standard laparoscopic textbooks. The accessory obturator nerve was mistakenly identified as the main nerve, and this confusion was a factor in the patient's injury.[5]

The basis for the existence of the present variant of AON can be explained by reviewing the embryological basis. Developmentally, it has been suggested that this small nerve may have been separated from the obturator nerve during the formation of the obturator foramen.[14] Howell AB noted that the pubis develops first as a process, subsequently hooking around the ON and joining the ischium so as to enclose this nerve in the obturator foramen.[15] The small AON arises from the lumbar plexus by roots from the third and fourth lumbar nerves and it emerges between the obturator and femoral nerves. Eisler P noted that the roots of the AON push out between those of the pre-axial obturator and the postaxial femoral nerves. At the same time, he unequivocally classified the accessory nerve as parts of the ventral division of the lumbar plexus.[8] The anatomical variations of AON are important to anesthetists, orthopedic surgeons, neurophysicians, physiotherapist and radiologists. Such comprehension is useful in delivering complete anesthesia along the obturator nerve supply and nerve grafting for peripheral neuropathies.[16]

Conclusion

The presence of AON is clinically important as it is also considered during ON blockade. The AON blockade can be indicated in superficial surgeries of thigh, treatment of pain due to thigh tourniquet, as a diagnostic aid for pain syndromes in the hip joint, inguinal areas or lumbar spine, and in relief of intractable hip pain due to osteoarthritis. The anatomical variations of nerve plexuses are also important to anesthetists, orthopedic surgeons, neurophysicians, physiotherapist and radiologists. Such comprehension is useful in delivering complete anesthesia along the obturator nerve supply, nerve grafting, neurophysiological evaluation for diagnosing peripheral neuropathies.

References

1. Swanson LW. Neuroanatomical Terminology: A Lexicon of Classical Origins and Historical Foundations. Oxford University Press; 2015.p. 29.
2. Cruveilhier J. The anatomy of the human body. New York (NY): Harper and Brothers; 1844.
3. McMinn RMH. Last's Anatomy: Regional and Applied, 9th edition. Marrickville (NSW) Australia: Elsevier; 2003.p.397.
4. Standring S, Borley NR, Collins P, *et al.* Editors. Posterior Abdominal Wall and Retroperitoneum. In Gray's Anatomy. 40th edition. London: Churchill Livingstone; 2008. pp. 1069–81.
5. Jirsch JD, Chalk CH. Obturator neuropathy complicating elective laparoscopic tubal occlusion. Muscle Nerve. 2007;36:104–6.
6. Akkaya T, Comert A, Kendir S, *et al.* Detailed anatomy of accessory obturator nerve blockade. Minerva Anestesiol. 2008;74(4):119–22.
7. Turgut M, Matthew Protas, Brady Gardner, *et al.* The accessory obturator nerve: An anatomical study with literature analysis. Anatomy. 2017;11(3):121–27.
8. Eisler P. Der Plexus lumbosacralis des Menschen. Anat Anz. 1891;6:274–81.
9. Bardeen CR, Elting AW. A statistical study of the variations in the formation and position of the lumbosacral plexus in man. Anat Anz. 1901;19:124–8, 209–32.
10. Kaiser RA. Obturator neurectomy for coxalgia: An anatomical study of the obturator and the accessory obturator nerve. J Bone Joint Am. 1949;31:815–19.
11. Woodburne RT. The accessory obturator nerve and the innervation of the pectineus muscle. Anat Rec. 1960;136:367–69.
12. Katritsis E, Anagnostopoulou S, Papadopoulos N. Anatomical observations on the accessory obturator nerve (based on 1000 specimens). Anat Anz. 1980;148:440–5.
13. Anloague PA, Huijbregts P. Anatomical variations of the lumbar plexus: A descriptive anatomy study with proposed clinical implications. J Man Manip Ther. 2009;17:e107–e14.
14. Bolk L. Beziehungen Zwischen Skelett, Muskulatur and Nerven der Extremitaten. Mowh Jb. 1894;21:241–77.
15. Howell AB. The phylogenetic arrangement of the muscular system. Anat Rec. 1936;66: 295–316.
16. Rohini M, Yogesh AS, Banerjee C, *et al.* Variant accessory Obturator Nerve: A case report and embryological review. Research and Reviews: Journal of Medical and Health Sciences. 2012 Oct–Dec;1(1)

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Study of Correlation of Hand Parameters with Stature in Humans

Methepatil Supriya S[1], Herekar NG[2]

Abstract

Aims: The aim of the present study is to study the correlation of hand parameters with stature. *Materials and Methods:* Sample size of the present study consisted of 200 students (Males = 84 and Females = 116) between 17 and 24 years of age from Government Medical College. Their stature and hand parameters were recorded. *Results:* It was observed that males had higher mean, standard deviation and range for each of the parameter considered than those of females. Significant correlation was observed between height and the hand parameters. From the regression equations derived, one can calculate height from any known parameter and *vice versa*. *Conclusion:* Hand length and hand breadth showed statistically significant correlation with height in total cases and also when male and female cases were evaluated separately. Hand length and hand breadth also show significant positive correlation with each other. When one has to calculate height using one parameter, we recommend the use of hand length for the same as it showed highest correlation with height. This study will be useful for stature estimation from available skeleton material or parts of the deceased body that are available.

Keywords: Correlation; Hand; Parameters; Stature.

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Introduction

Growth which is the vital process is measured by measuring the height of a person.[1] Stature estimation is an important factor in identification of commingled remains in forensic examinations.[2.] It has been proved that stature can be estimated from imprints of hand, foot or from a shoe left at the scene of a crime. Hand length has also been studied by various researchers to predict stature.[3] It has been proved that hand length can predict body weight and body surface area independently of the gender of the subject[4] This study is done to estimate height of an individual from measurement of hand length, hand breadth and also to study the correlation among these parameters themselves.

Aim

To study the correlation of foot parameters with stature.

Materials and Methods

Sample size of the present study consisted of 200 students (Males = 84 and Females = 116) from Government Medical College. Subjects known to have any significant disease, orthopaedic deformity, metabolic or developmental disorders which could have affected the general or bony

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growth were not included in this study. The age of the sample group ranged between 17 and 24 years. The parameters studied were stature *i.e.,* height, hand length and hand breadth. The material used for the present study was standiometer (height measuring instrument), measuring scale, paper, pencil.

The measurements were taken on both sides in each subject by using standard anthropometric instruments in centimeter in the following manner:

Height of the individual was measured as vertical distance from the vertex to the floor. Measurement was taken by making the subject stand erect on a horizontal resisting plane bare footed. No pressure was exerted since this is a contact measurement.[5]

Hand measurements

Before taking measurements, it was checked that nails were trimmed. Each subject was asked to place his/her hand on a white paper with palm facing upwards keeping the fingers close together with thumb lying comfortably but not tightly against the radial aspect of the hand and index finger. A tracing of the hand was made with a lead pencil. The tracing proceeded from the radial styloid process to the ulnar styloid process.[6] Care was taken to see that there was no abduction or adduction at wrist joint, *i.e.,* forearm was directly in line with the middle finger[7] (**Fig. 1**).

Fig. 1: Showing hand tracing done.

1. *Hand Length*: A line was drawn joining the two styloid tips. This line is designated as the interstyloid line (**Fig. 2**). Distance between the midpoint of the interstyloid line and the tip of the middle finger in extension was measured as length of the hand.[6,8,9]
2. *Hand breadth*: Hand breadth was measured as the distance between the lateral aspect of index finger from where the thumb diverges and the natural concavity near the palmer digital creases on the medial aspect of little finger[6] (**Fig. 2**).

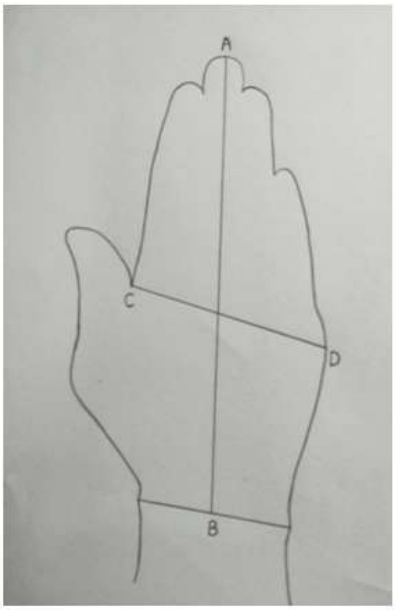

Fig. 2: Landmarks for hand measurements[6]:

Distance between A and B = Hand length;

Distance between C and D = Hand Breadth.

Results

The data was analysed using SPSS software version 20.

As there was no significant difference between the measurements of right and left sides, we have taken the average of the right and left sides of each parameter into consideration for the study.

From **Table 1**, one can note that males had higher mean, standard deviation and range for each of the parameter considered than those of total cases which are higher than those of females. $p < 0.01$ indicates that the probability of difference being due to chance is less than 1%.[10] This proved that the difference between the values of Males and Females is highly significant.

The extent or degree of relationship is measured by correlation co-efficient which is denoted by '*r*'. '*r*' ranges between -1 and +1. If $r = 1$, it indicates perfect positive correlation with two variables directly proportional to each other; $r = -1$ indicate perfect negative correlation with two parameters inversely proportional to each other; *r* between 0 and 1 indicate two variables are directly proportional to each other and have a moderate positive correlation, *r* between 0 and -1 indicate two variables are inversely proportional to each

Table 1: Distribution of various parameters in study population with '*t*' values indicating the difference in Male and Female parameters.

Sl. no.	Parameter		Total Cases	Males	Females	t	*p* Value
1	Height	Mean ± SD	163.08 ± 8.36	169.76 ± 6.42	158.23 ± 5.90	13.149**	0.001
		Range	142–185	155–185	142–171		
2	Average Hand Length	Mean ± SD	17.72 ± 1.14	18.58 ± 0.97	17.09 ± 0.80	12.002**	0.001
		Range	14.95–21.25	16.6–21.25	14.95–18.65		
3	Average Hand Breadth	Mean ± SD	7.52 ± 0.57	8.02 ± 0.46	7.17 ± 0.36	14.582**	0.001
		Range	6.05–9.1	7–9.1	6.05–7.95		

If $p \leq 0.01$ or 0.001 Highly Significant ** Highly Significant

other and have a moderate negative correlation.[10]

Pearson's correlation co-efficient (*r*) for height and hand length is 0.717, 0.510 and 0.479 for total cases, males and females respectively. Pearson's correlation co-efficient (*r*) for height and hand breadth is 0.619, 0.224 and 0.282 for total cases, males and females respectively. Pearson's correlation co-efficient (*r*) for hand length and hand breadth is 0.733, 0.499 and 0.510 for total cases, males and females respectively. All values are significant at 0.01 level (p = 0.001). Correlation of height with hand length and hand breadth is highly significant; hand length showing stronger correlation than hand breadth. Also hand length and hand breadth show highly significant correlation among them.

Linear regression model[10] is given by:

$$y = a + bx$$

where y = dependent variable (which is height in our case)

x = independent variable (Hand Length/ Hand Breadth)

b = regression co-efficient

a = intercept (a constant)

The linear equations derived for calculating height from hand length are:

For total cases: Height = 70.128 + 5.246 HL

$R^2 = 0.515$ and f value = 209.94, $p = 0.001$

For males: Height = 106.76 + 3.389 HL

$R^2 = 0.261$ and f value = 28.89, $p = 0.001$

For females: Height = 97.64 + 3.546 HL

$R^2 = 0.229$ and f value = 33.89, $p = 0.001$

The linear equations derived for calculating height from hand breadth are:

For total cases: Height = 96.506 + 8.848 HB

$R^2 = 0.383$ and f value = 123.05, $p = 0.001$

For males: Height = 144.93 + 3.098 HB

$R^2 = 0.05$ and f value = 4.34, $p = 0.040$

For females: Height = 125.15 + 4.616 HB

$R^2 = 0.079$ and f value = 9.83, $p = 0.002$

If $p \leq 0.01$ or 0.001 Highly Significant

$p \leq 0.05$ Significant

The high '*f*' value with low '*p*' value indicates significant functional relationship between dependent variable and independent variable. *R* square is the square of the correlation co-efficient.[10] It determines the strength of association among the parameters considered. In equation of deriving height from hand length in total cases, it is 0.515 which indicates that 51.5% of variation in height is due to variation in hand length. From the linear equation model, it is clear that height can be better predicted from hand length than hand breadth.

Multiple regression model is given by: $y = \beta_0 + \beta_1 (HL) + \beta_2 (HB)$

where y = dependant variable (height in our case)

β_0 = regression co-efficient

β_1 = regression co-efficient for HL

β_2 = regression co-efficient for HB

For total cases: Height = 67.60 + 4.17HL + 2.88HB

$R = 0.73$, $R^2 = 0.53$ and f value = 112.60, $p = 0.000$

For males: Height = 108.76 + 3.52HL – 0.56HB

$R = 0.51$, $R^2 = 0.26$ and f value = 14.36, $p = 0.000$

For females: Height = 94.95 + 3.35HL + 0.83HB

$R = 0.48$ $R^2 = 0.23$ and f value = 16.98, $p = 0.000$

The multiple correlation co-efficient (*R*) was highly significant at p =0.001.

Thus, height can be calculated from all the parameters with good accuracy by using multiple regression equation.

Multiple regression model fitted well to the observed data than the linear regression model as the values of multiple correlation co-efficients

are a bit higher than the Pearson's correlation co-efficients.The results of the present study show that there was strong positive and significant correlation of height with hand length and hand breadth respectively. There also existed a strong positive significant correlation among these parameters themselves.

It must be noted that these equations are applicable to the population from which data has been collected because genetic, racial and environmental factors (climate, nutrition etc.) may influence the parameters under consideration.

Discussion

Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other[1]. Establishing the identity of an individual from mutilated, decomposed, and amputated body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. It is important both for legal and humanitarian reasons.[12] But there are inter-racial and inter-geographical differences in measurements and their correlation with stature. What may be true for one race or one region may not be true for the other.[13]

The difference between male and female measurements was statistically significant. These differences in stature and foot measurements between males and females can be attributed to the fact that fusion of epiphyses of bones occurs earlier in girls in comparison to boys. Boys have about two more years of bony growth than girls.[14]

We observed that mean value of height in our study matches with the findings of Khanapurkar[15] (2012) and Patel[16] (2012) but is lower than the findings of Bhatnagar[17] (1984), Sanli[18] (2005), Chikhalkar[13] (2009) and Jakhar[19] (2010). Bhatnagar[17] (1984) has done their study in Punjabi population, Jakhar[19] (2010) studied the Haryanvi population whereas Sanli[18] (2005). Punjabi and Haryanvi are known to have larger stature than the Western Indian population. Our study supports the same finding.

Mean hand length of our study is lower than the findings of Bhatnagar[17] (1984), Sanli[18] (2005); whereas it is comparable with the rest of the studies done.

Mean hand breadth of our study is comparable with the findings of the other studies done by the various authors mentioned above.

The difference in the findings of present study from those of the other studies may be attributed to the geographical as well as racial factors that may influence growth and stature of an individual.In the present study, we observed highly significant differences in all dimensions of males and females. Jakhar[19] (2010) reported similar significant differences in males and females.

Comparison of Correlation Co-efficients

Correlation co-efficient between two parameters gives us an idea whether these parameters are related to each other or not; if yes then to what extent.

Chikhalkar[13] (2009) observed that correlation co-efficients (*r*) of hand length and breadth with height to be 0.5902 and 0.6004 respectively. Patel[16] (2012) observed '*r*' values for hand length and breadth to be 0.806 and 0.467 respectively. The findings of our study are comparable with those of the above studies.

Jasuja and Singh[20] (2004) measured stature and phalanges length of all fingers of both the hands in 60 sixty adult male and female Jat Sikhs. No bilateral difference in the hand length or any statistically significant difference was observed in print length from the actual hand length.

Height can be calculated from hand length and hand breadth separately using linear regression equations derived from the present study. Similar equations are derived by various authors like Bhatnagar[17] (1984), Chikhalkar[13] (2009), Patel[16] (2012).

In multiple regression equations, various parameters are used to calculate the dependant variable which was height in present case. These equations predict height better than the linear equations which takeonly one parameter into consideration.

Khanapurkar and Radke[15] (2012) studied estimation of stature from the measurement of foot length, hand length and head length. They found that contribution of head length in estimating height was not significant when it was considered with hand length and foot length. So they derived the equation taking hand length and foot length into consideration. The equation derived by them was Height = 59.451 + 2.552 FL + 2.295 HL.

Conclusion

Present study was designed to estimate height from hand length and hand breadth. Correlation among these parameters was also studied.

- The difference in the measurements of males and females was statistically highly significant for each parameter.
- Hand length and hand breadth showed statistically significant correlation with height in total cases and also when male and female cases were evaluated separately.
- Hand length showed better correlation with height in all cases (r = 0.717) as well as in males (r = 0.510) and females (r = 0.479) separately than by hand breadth.
- Hand length and hand breadth also shows significant positive correlation with each other (r = 0.733, 0.499, 0.510).
- Linear and multiple regression equations were formulated which will help to calculate height from single parameter and both parameters respectively.
- When one has to calculate height using one parameter, we recommend the use of hand length for the same as it showed highest correlation with height.
- This study will be useful for stature estimation from available skeleton material or parts of the deceased body that are available.

References

1. Patel SM, Shah GV, Patel SV. Estimation of height from measurements of foot length in Gujarat Region. J Anat Soc, India. 2007;56:25–7.
2. Lundy J. The mathematical versus anatomical methods of stature estimate from long bones Am J Forensic Med Pathol. 1985;6:73–5.
3. Saxena SK. A study of correlations and estimation of stature from hand length, hand breadth and sole length. Anthropology Anz. 1984;42:271–76.
4. Standring S. Gray's anatomy, 39th edition. Philadelphia: Elsevier Churchill Livingstone. 2005;889–924,1507–542.
5. Iscan MY, Quatrehomme G. Medico-legal anthropology in France. Forensic Sci Int. 1999;100:17–35.
6. Zverev YP. Relationship between arm span and stature in Malawian adults. Ann Hum Biol. 2003;30:739–43.
7. Lundy JK. Living stature from long limb bones in the South African Negro. S Afr J Sci. 1983;79:337–38.
8. Lundy JK. Revised equations for estimating living stature from the long bones of the South African Negro. S Afr J Sci. 1987;83:54–5.
9. Dayal MR, Steyn M, Kuykendall KL. Stature estimation from bones of South African whites. S Afr J Sci. 2008;104:124–28.
10. Mahajan BK. Methods in biostatistics for medical students and research workers, 7th edition. Jaypee Brothers Medical Publishers Ltd, New Delhi. 2010.
11. Krishan K. Anthropometry in forensic medicine and forensic science forensic anthropometry. Internet J Forensic Sci. 2007;2(1):1–17.
12. Ismaila SO. Anthropometric data of hand, foot ande of university students in Nigeria. Leonardo Journal of Sciences. 2009 Jul–Dec;15(8):15–20.
13. Chikhalkar BG, Mangaonkar AA, Nanandkar SD, *et al.* Estimation of stature from measurements of long bones, hand and foot dimensions. JIAFM. 2009;32:329–31.
14. El-Meligy MMS, Abdel-Hady RH, Abdel-Maaboud RM, *et al.* Estimation of human body built in Egyptians. Forensic Sci Int. 2006;159:27–31.
15. Khanapurkar S, Radke A. Estimation of stature from the measurement of foot length, hand length and head length in Maharashtra Region. Indian Journal of Basic and Applied Medical Research. 2012 March;1(2):77–85.
16. Patel PN, Tanna JA, Kalele SD. Correlation between hand length and various anthropometric parameters. International Journal of Medical Toxicology and Forensic Medicine. 2012;2(2):61–63.
17. Bhatnagar DP, Thapar SP, Batish MK. Identification of personal height from the somatometry of the hand in Punjabi Males. Forensic Sci Int. 1984;24:137–41.
18. Sanli SG, Kizilkanat ED, Boyan N, *et al.* Stature estimation based on hand length and foot length. Clin Anat. 2005;18(8):589–96.
19. Jakahar JK, Pal V, Paliwal PK. Estimation of height from measurements of foot length in Haryana Region. J Indian Acad Forensic Med. 2010;32(3):231–33.
20. Jasuja OP, Singh G. Estimation of stature from hand and phalange length. J Ind Acad Forensic Med. 2004;26(3):100–106.

Original Article

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Morphometric Study of Tricuspid Valve Annulus and Right Ventricular Papillary Muscle: A Cadaveric Study from Marathwada Region

Mukta Pande[1], Shivaji Sukre[2], Pratima Kulkarni[3]

Abstract

Tricuspid valve complex is commonly involved in various heart diseases like rheumatic heart diseases, congenital cardiac anomalies etc. Studies on Tricuspid valve complex, in Maharashtrians are few; so the present work was undertaken. Thirty five formalin fixed embalmed adult heart obtained by dissecting cadavers allotted to undergraduate students in GMC, Aurangabad, were studied irrespective of gender and cause of death. In present study circumference of tricuspid valve annulus was **(**mean +/- SD) 10.96 +/- 1.36 *cm* with range 8.6 *cm* to 13.6 *cm*; Diameter at minimum separated points (D1) was in the range of 2 *cm* to 3.5 *cm* and diameter measured at maximally separated points (D2) were in range 2.8 *cm* to 4.4 *cm*. Occurrence of papillary muscle was noted, anterior and posterior papillary muscle were present in all specimens however septal papillary muscle was absent in 9 out of 35 specimens. Anterior papillary muscle dimensions were noted; mean length for it was 1.224 *cm* +/- 0.478 *cm* with range 0.4 *cm* to 2 *cm* and mean thickness was 0.488 *cm* +/- 0.182 *cm* (range 0.3 *cm* to 0.9 cm).Knowledge of anatomy of tricuspid valve complex bears importance for operative procedures on tricuspid valve abnormalities. Present study data might be useful for cardiothoracic surgeons for newer surgical techniques like papillotomy, correction of papillary rupture induced tricuspid regurgitation.

Keywords: Anterior papillary muscle; Tricuspid valve.

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Introduction

Tricuspid valve complex is commonly involved in heart diseases due to rheumatic, age related and congenital causes. As cadaveric study is still best way to study human anatomy; in present work embalmed heart allotted to undergraduate students were studied for tricuspid valve annulus dimensions, and occurrence of papillary muscles. Readings were taken for anterior papillary muscle because of its easy accessibility.

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As Grays clinical anatomy mentions "The tricuspid valve orifice is best seen from the atrial aspect and measures on average 11.4 *cm* in circumference in Males and 10.8 *cm* in Females." There exist a clear line of transition between atrial wall and the lines of attachment of the valvular cusps. The tricuspid valve orifice margins are not precisely in a single plane but are almost vertical making *at a 45° angle* to the sagittal plane with slightly inclination to the vertical, such that its ventricular aspect faces anterolaterally to the left and somewhat inferiorly. Tricuspid valve orifice is roughly triangular.[1]

The atrioventricular valvular complex, include orifice and its associated annulus, the cusps, the supporting chordae tendinae of various types and the papillary muscles.[1]

Usually there are three papillary muscles in the right ventricle (1) large posterior papillary muscle attached to inferior wall (2) A larger anterior

papillary muscle, attached to anterior wall and (3) several small septal papillary muscles, or simply chordae tendinae, pass from septum to the anterior and septal cusp. The anterior and posterior papillary muscles are occasionally divided into a number of smaller projections.[2]

Victor S and Nayak[3] described about interior of the ventricles that it is as unique to each individual as one's fingerprint as they observed that numerous variations were present in the configuration of the cusp tissue and chordal/papillary support of the ventricular wall.[3]

Present study did observation for occurrence of right ventricular papillary muscles. Anterior papillary muscle and posterior papillary muscle were present in all specimens but septal papillary muscle was absent in 9 out of 35 specimens. In hearts with absent septal papillary muscle chordae were directly teethered to septal wall (**Fig. 7**).

Readings were taken for tricuspid valve orifice and anterior papillary muscle; data of it adds to previous study data and might be useful for cardiac surgeons for procedures like valvuloplasty, papillotomy, papillary muscle repair etc.

Materials and Methods

With prior permission of HOD of Anatomy Department; study was conducted on 35 embalmed adult heart specimen obtained by dissecting cadavers allotted to undergraduate students in Government Medical College, Aurangabad. Irrespective of gender and cause of the death specimens were studied.

Method of dissection for extracted heart specimen

Dissection was performed according to standard techniques (base of heart method) for tricuspid valve. To expose tricuspid orifice incision started at junction of the inferior vena cava with right atrium with scissors and extended into the right atrium, staying about 0.5–1.0 *cm* above the tricuspid valve annulus. Blood clots if present were removed (**Fig. 1**).

To study interior of right ventricle standard autopsy technique were followed. Cut was taken parallel to interventricular groove from point near right atrium to the inferior border of heart. Another cut was taken from first point to the inferior border; parallel to atrioventricular groove. Triangular flap was pooled downward and clots were removed to observe interior of right ventricle (**Fig. 2**).

Readings for tricuspid valve circumference were done by firmly applying malleable metal wire to tricuspid annulus and then straightening the wire and taking readings on measuring scale. Maximum and minimum diameters were recorded by Vernier Caliper (**Fig. 3**).

Similarly Length of anterior papillary muscle was recorded from the base/junction of papillary muscle to right ventricle to the apex of papillary muscle (**Fig. 5**). Maximum width of Anterior papillary muscle was recorded with Vernier Calliper (**Fig. 6**). Interior of Right ventricle was observed (*e.g.*, **Fig. 8**). Observations were done about occurrence of three papillary muscles in right ventricle: APM, PPM, SPM. Mean, Standard Deviation and Range were obtained for study parameters. Results obtained were compared with previous studies.

Fig. 1: Showing incision starting from IVC and extending into atrial wall above right atrio ventricular groove

Fig. 2: Showing incision on Right ventricle exposing interior of right ventricle

Fig. 3: Method of measurement of diameter of tricuspid valve with Vernier Caliper

Fig. 4: Measurement of tricuspid valve annulus by applying malleable metal wire to the circumference of tricuspid annulus

Figs. 5 and 6: Method of taking length and thickness of APM taken with the help of Vernier Caliper

Fig. 7: Specimen no. 5 with chordae tendinae directly teethered to interventricular septum (Arrow)

Results and Observations

The results of the study are shown in **(Tables 1–5)** as follows:

Table 1: Measurements for Tricuspid Valve annulus

Tricuspid valve parameter	Mean in cm	S.D. in *cm*	Range in *cm*
Circumference	10.96	± 1.36	8.6–13.6
Diameter at minimum separated point D1	2.97	± 0.383	2–3.5
Diameter at maximum separated point D2	3.51	± 0.417	2.8–4.4

Table 2: Measurements of Anterior Papillary Muscle

Anterior Papillary muscle Parameter	Mean in *cm*	S.D. in *cm*	Range in *cm*
Length	1.224	± 0.478	0.4–2.0
Thickness	0.4885	± 0.1827	0.3–0.9

Observations

In the study sample Anterior and Posterior papillary muscle were present in all hearts; Septal papillary muscle was least prominent and in 9 out of 35 specimens; septal papillary muscles were absent (25.71%).In those specimens with absent septal papillary muscle Chordae were directly teethered to interventricular septum. (**Fig. 7**). Anterior papillary muscle was the most prominent, longest and was frequently (16 out of 35 specimens) (45.71%); bifid/biheaded (*e.g.*, **Fig. 11**).

Few noticeable variations in papillary muscle were:

(a) In specimen no 7 anterior papillary muscle was fused with thick bridge from interventricular septum at apex (instead of base) and at the junction of two the chordae were attached. (**Fig. 9**)

(b) In two specimens; two APM; almost of same size were observed (**Fig. 10**)

(c) One large APM and another thin APM (with almost of same length but with few 1 or 2) chordae attached at its apex) were observed in 3 specimens. (*e.g.*, in **Fig. 11**).

(d) One of the specimens had three APM (**Fig. 12**).

Fig. 8: Specimen showing Anterior papillary muscle arrow) and septal papillary muscle (triangle)

Fig. 9: Specimen showing AP and Moderator band fused at apex and chordae tendinae arising from the junction of two

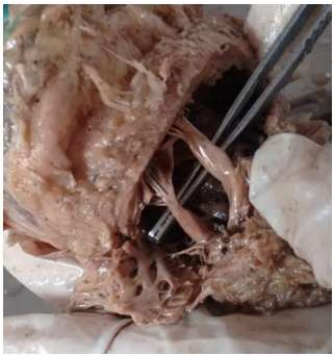

Fig. 10: Two specimens with two APM of almost same size

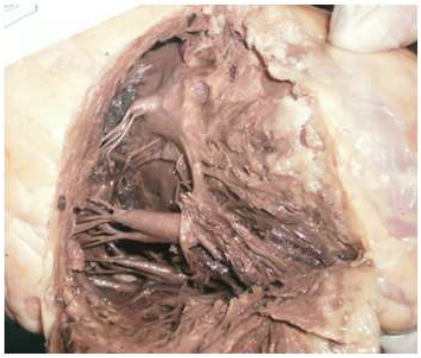

Fig 11: Specimen showing APM with 2 heads; small SPM near pulmonary orifice is present. Thin papillary muscle almost of same length is noted to left of that of bifid large APM

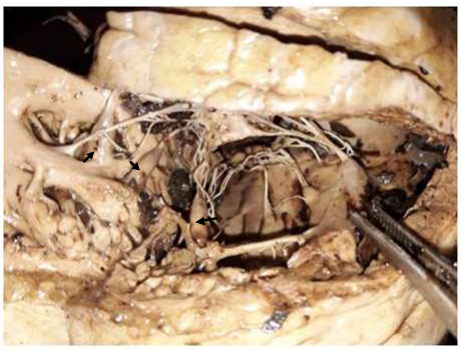

Fig. 12: Specimen with three APM (Black arrow)

Discussion

As observed by Victor S and Nayak (1994) in100 normal human heart specimen; numerous variations were present in the configuration of the cusp tissue and chordal/apillary support of the ventricular wall and these made the interior of the ventricles as unique to each individual as one's fingerprint.[3]

Comparison of study result was done with previous studies:

Range D1 2–3.5 *cm*; D2 2.8–4.4 *cm*; Thus from **Table 1 and 2** present study result were comparable with previous study data.

Dimensions of Anterior Papillary muscle

Dimension of Gerola *et al.*[12] are for paediatric population so they are smaller than present study. Readings by Negri *et al.*[13] is of higher range (1.9 *cm*). Racial factor may be the cause for higher values by this study. Study by Harsha BR, Chandrashekhar KT[9] on Indian population shows; APM mean height was 1.49 ± 0.44 *cm*; mean width was 0.82 ± 0.21 *cm* and mean thickness was 0.64 ± 0.15 *cm*.[14] While present study has mean height of APM 1.224 ± 0.478 *cm* and Max thickness of Anterior papillary muscle as mean 0.4885 ± 0.1827.

In study by Farzana T *et al.*[16] the specimens were grouped according to age into three categories.

Table 3: Comparison of circumference of Tricuspid Valve annulus with previous studies

Sl. no	Studies	Circumference of TV annulus
1	Grays Anatomy[1]	11.4 *cm* in males 10.8 *cm* in females
2	Tie C. *et al.* (1982)[4]	11.3 ± 0.9 *cm*
3	Silver *et al.* (1971)[5]	11.4 ± 1.1 *cm* in males 10.8 ± 1.3 *cm* in females
4	Motabagani (2006)[6]	11.8 to 13.9 *cm* in males 11.3 to 12.4 *cm* in females
5	R. Kalyani (2012)[7]	8.9–10.7 *cm* in males 8.5–10.4 *cm* in females
6	Babita Kujur[8]	9.7 ± 1.029 *cm*
7	Balchandra N *et al.*[9]	mean 10.01 ± 1.31 *cm* range 5.7–14.8 *cm*
8	Present Study	mean 10.96 ± 1.36 *cm* range 8.6–13.6 *cm*

Table 4: Comparison of Tricuspid Valve annulus with previous studies

Sl. no	Studies	Diameter of TV annulus in (*cm*)
1	Singh B and Mohan JC (1994)[10]	2.26
2	John F Secombe *et al.* (2004)[11]	2.13± 0.03
3	Babita Kujur[8]	2.1± 0.43 (D1); 3.03 ± 0.546 (D2)
4	Balchandra N *et al.*[9]	2.74 ± 0.78 D1; 2.48 ± 0.63 D2
5	Present Study	D1 mean 2.97 ± 0.383; D2 mean 3.51 ± 0.417

Table 5: Comparison of Anterior Papillary Muscle Dimensions with other studies

Sl. no.	Name of studies	Length of Anterior Papillary Muscle *cm*	Thickness of Anterior Papillary Muscle *cm*
1	Gerola *et al.*[12]	0.9 ± 0.2	1.2 ± 0.3
2	Negri GR *et al.*[13]	1.9	
3	Harsha BR, Chandrashekhar KT[14]	1.49 ± 0.44	0.64 ± 0.2 *cm*
4	Saha A, Roy S[15]	2.19 ± 0.59 *cm*	0.76 ± 0.26 *cm*
5	Farzana T *et al.*[16]		
	Group A (upto *20 years*)	1.07 ± 0.48 *cm*	
	Group B (*21 to 40 years*)	1.50 ± 0.37 *cm*	
	Group C (*41 to 60 years*)	1.60 ± 0.25 *cm*	
6	Present study	1.224 ± SD 0.478 *cm*	0.4885 ± SD 0.1827 *cm*

They measured length of each papillary muscle in both ventricles in different age groups and observed that the mean length of anterior, posterior and septal papillary muscle was increased with age.

Presence of Papillary muscle

In present study APM was most prominent and SPM was least prominent of the three papillary muscles; in 9 specimens out of 35 specimens; SPM were absent (25.71%). In study by Begum[17] on 49 fixed hearts from 39 male and 11 female Bangladeshis aged 20 to 70 years and without any known cardiac disorder; the SPM was single in 46% cases while in 30% cases it was absent. In the right ventricle, the APM were the longest and the SPM were the shortest.[17]

Conclusion

Findings for tricuspid valve circumference and diameter were within the range given in literature[1] and those given in previous studies[4,5,6,7]. APM being largest and frequently biheaded. The SPM itself was the least prominent and frequently absent; in specimens with absent SPM chordae tendinae were directly attached to interventricular septum. Dimensions of APM were comparable with previous studies.[13,14,15,16]

Present study data adds to previous studies on tricuspid annulus morphometry especially performed on Indian population from Marathwada region. Present study might be useful for cardiothoracic surgeons for tricuspid valve complex procedures like papillotomy, papillary muscle repair.

Abbreviations:

APM-Anterior Papillary Muscle;

PPM-Posterior Papillary Muscle;

SPM-Septal Papillary Muscle.

References

1. Susan Standring. Gray's Anatomy. The Anatomical basis of clinical practice Churchil Livingston Elsevier, 14th edition. 2008.p.966.
2. Romanes GJ. Cunninghams Manual of Practical Anatomy, Volume 2; 5th Edition, Thorax and Abdomen: Oxford medical publications; 2004. p.51.
3. Victor S, Nayak VM. The tricuspid valve is bicuspid. J Heart Valve Dis. 1994.pp.27–36.
4. Tie C, JP Pilgrim, PM Shaw, *et al.* The tricuspid valve annulus: Study of size and motion in normal subjects and in patient with tricuspid regurgitation. Circulation. 1982 Sep;66(3):665-71.
5. Silver MD, Lam JHC Ranganathan N, Wigle ED. Morphology of the human tricuspid valve, Circulation. 1971;43:333–48.
6. Mohamed AB, Motabagan. Comparative Anatomical, Morphometric and Histological studies of the Tricuspid Valve-Complex in human and some mammalian hearts. J Anat Soc, India. 2006;55:1–23.
7. Kalyani R, Thej MJ, Prabhakar K, *et al.* Morphometric analysis of tricuspid valve: An Indian perspective. J Nat Sci Biol Med. 2012 Jul–Dec;3(2):147–51.
8. Babita K, Narendra T and Renu P. Dimensions of human adult Tricuspid Valve annulus in the Embalmed Cadavers. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS). 2016

August;15(8):Ver.IV:94–98.

9. Balachandra, Ramesh NBR. A study of the dimensions of the human tricuspid Valve. International Journal of Anatomy and Research. 2018;6(3.3):5652–659.
10. Singh B, Mohan JC. Atrioventricular valve orifice areas in normal subjects: determination by cross sectional and Doppler echo cardiography. Int J Cardiol. 1994 15th March; 44(1):85–91.
11. John F Secombe, Donald R Cahill, William D Edwards. Quantitative Morphology of the normal human tricuspid valve. Autopsy study of 24 cases. Clinical Anatomy. 2002 Jan;6(4): 203–12.
12. Gerola LR, Wafae N, Vieira MC, *et al.* Anatomic study of the Tricuspid valve in children. Surg Radiol Anat. 2001;23:149–53.
13. Negri GR, Didio LJA, Baptista CAC. Papillary muscles and tendinous chords of the right ventricle of the human heart morphological characteristics. Surg Radiol Anat. 2001;23:149-53.
14. Harsha BR, Chandrashekhar KT. Cadaveric Study on anterior and posterior papillary muscles of tricuspid valve. Int J Anat Res. 2015;3(1):865-68.
15. Saha A, Roy S. Papillary muscles of right ventricle-morphological variations and its clinical relevance. Cardiovasc Pathol. 2018 May–Jun;34:22–27. DOI: 10.1016/j. carpath.2018.01.007. Epub 2018 9th Feb; Assessed on 28/5/9 on *1.47 pm.*
16. Farzana T, Khalil M, Mannan S, *et al.* Length of papillary muscles in both ventricles of different age group on Bangladeshi cadaver. Mymensingh Med J. 2015 Jan;24(1):52–8.
17. Begum JA, Khalil M, Rahman H, *et al.* A morphological and morphometric study of the right ventricular papillary muscles of autopsied heart of Bangladeshi people. Mymensingh Med J. 2006 Jul;15(2):131–34.

Original Article

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Comparative Study of Body Mass Index (BMI), Body Fat Percentage and Muscle Mass in Male and Female Medical Students

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Abstract

Objectives: According WHO increased BMI is major risk factor for major non communicable diseases like Diabetes Mellitus, Heart diseases, Some form of cancers etc. prevalence of obesity has increased significantly in past few decades. WHO considers BMI as important parameter to assess the degree of obesity. Our present study was aimed to study other better way to assess the Obesity which is a better indicator than BMI. *Materials and Methods:* Present study was conducted on 130 subjects of 18 years of age, of both sexes, of these 80 subjects were non-obese females and 50 were non-obese males. This study was conducted in the department of anatomy, GSL Medical College, Rajamahendravaram, AP by using body composition monitor (model-BHF-362, KARADA SCAN). *Results:* On analyzing the results it is found that body fat percentage in females is significantly more (p-Value < 0.0001) when compared to male subjects of same age and almost equal BMI (mean BMI 23.08 and 23.48). Significant difference was also found in the regional distribution of Fat. *Conclusion:* As there is significant difference in body fat% and its distribution among males and female subjects, body fat percentage should be consider for assessment of degree of obesity rather than BMI.

Keywords: Obesity; BMI; Body fat Percentage; Body composition monitor.

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Introduction

The prevalence of obesity and overweight among children and adolescents aged *5–19 Years* has increased from 4% to 18% in a span of *41 years i.e.*, from 1975 to 2016. According to WHO in 2016, about 39% of adults *aged 18 years* and above were overweight and overall 13% were obese[9] WHO states raised Body Mass Index (BMI) is a major risk factor for major non-communicable diseases such as Diabetes mellitus, heart diseases, stroke and certain cancers like carcinoma colon and endometrium.[10]

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WHO uses BMI as rough guide to categorize people in to overweight and obese but reliability of BMI as single dependable parameter to measure Obesity is the controversial topic among many medical and Health care researchers.

The American society of Bariatric physicians defines Obesity as ≥ 25 % body fat for males for females ≥ 30 % and these group of doctors will consider Body fat % rather than BMI when it comes to selecting patients for medical line of management for obesity and overweight.[7] Not only gender ethnicity may also be one of the important factor in relationship between BMI and Body Fat %, such differences were also found by M Deurenberg. Yap *et al.* in their study on Singaporeans, stated that they have higher body fat % at a lower BMI when compared with Caucasians.[5] But this ethnicity influence is not found in all the studies that are conducted.[6]

Apart from BMI and Body fat percentage the visceral fat is another most important indicator which correlates well with development of

conditions like Insulin resistance, cardiovascular diseases etc. Anthropometric measurements are indirect ways to assess the visceral fat, but most accurate ones are expensive CT scans and MRI scans[1] here we have opted bioelectrical impedance analysis for estimation of body fat% and visceral fat to compare with BMI.

Materials and Methods

This present research is conducted on 1st MBBS male and female medical students of *18 years of age*. College ethics committee permission obtained and informed written consent taken from all the voluntary participants. Total numbers of participants were 130 of which 50 were males and 80 female subjects. All the subjects included in the study were healthy and non-obese. Height of the subjects is measured without foot wear in meters nearest to 0.1 *cm* by using a wall mounted height measuring scale (WS-708). After feeding the data like age, gender, height of the subject the weight, BMI, Body fat%, skeletal Muscle Mass and regional distribution of the body fat and skeletal muscle mass were measured with the help of Body composition monitor with scale (Model-HBF-362, Karada Scan) which estimates the body fat% by bioelectrical impedance (BI) method. This method doesn't expose the individuals to radiation unlike CT scan.

All the measurements were taken 2 hours after consumption of food or before having lunch. The other precaution taken before the measurement was avoiding consumption of large quantity of water or liquid diet because the water content in the body may influence the accuracy of the readings.

Results

The data recorded from the subjects (50 males and 80 females) was statistically analyzed. Mean and standard deviations were calculated first and with that unpaired student *t*-test is used to test the statistical significance of the difference between body fat percentage, visceral fat percentage etc. of male and female subjects.

All the subjects are of *18 years of age* and their mean BMI was 23.0833 kg/mts^2 and 23.4833 kg/mts^2 females and males respectively. Though there is significant variation in their height and weight their BMI doesn't show any significant variation ($p < 0.5955$) (**Table 1)**.

Table 1: Comparison of Body Fat% and its distribution in the subjects

Sl. no.	Parameter		Females $n = 80$		Males $n = 50$		*t*-value	*p*-value
			Mean	STDEV	Mean	STDEV		
1	Height *cms*		160.4722	± 5.9312	172.6667	±8.6922	9.621	0.0001
2	Weight *Kg*		59.7388	± 6.8869	71.3333	±23.1415	4.213	0.0001
3	Fat %		29.3111	± 4.5658	20.2833	±7.7501	8.501	0.0001
4	BMI Kg/m^2		23.0833	± 2.7942	23.4833	± 5.5019	0.5323	0.5955
5	Visceral fat%		3.4117	± 1.4166	6.8333	± 5.3980	5.4006	0.0001
6	Whole body	Subcutaneous fat%	25.7277	± 4.1568	14.1833	± 5.6731	13.5312	0.0001
		Muscle mass%	26.3166	± 1.9336	34.4333	± 3.3174	17.6781	0.0001
7	Trunk	Subcutaneous fat%	21.6277	± 4.3509	12.6166	± 5.6333	10.3166	0.0001
		Muscle mass%	21.2111	± 2.1047	27.7833	± 4.6926	11.0950	0.0001
8	Legs	Subcutaneous fat%	39.2111	± 5.7704	21.15	± 8.3685	14.6948	0.0001
		Muscle mass%	38.7277	± 1.5726	51.6666	± 3.1982	32.1179	0.0001
9	Arms	Subcutaneous fat%	42.3722	± 5.6388	21.8	± 7.7822	17.5954	0.0001
		Muscle mass%	28.1833	± 3.4758	40.0166	± 3.0667	19.7711	0.0001

The total mean body fat% in females is more (29.3111) than the male subjects (20.2833) which is statistically significant (p-value < 0.0001). But visceral fat% is significantly more in males than in females (mean 6.8333 males, 3.4117 females with p-value < 0.0001), shown as in **(Figs. 1, 2** and **3).**

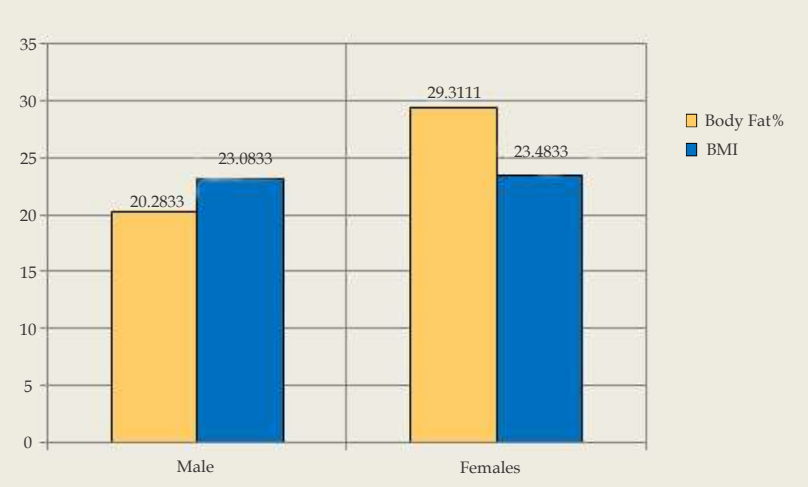

Fig. 1: Comparison of mean BMI and Body Fat% between male and female subjects

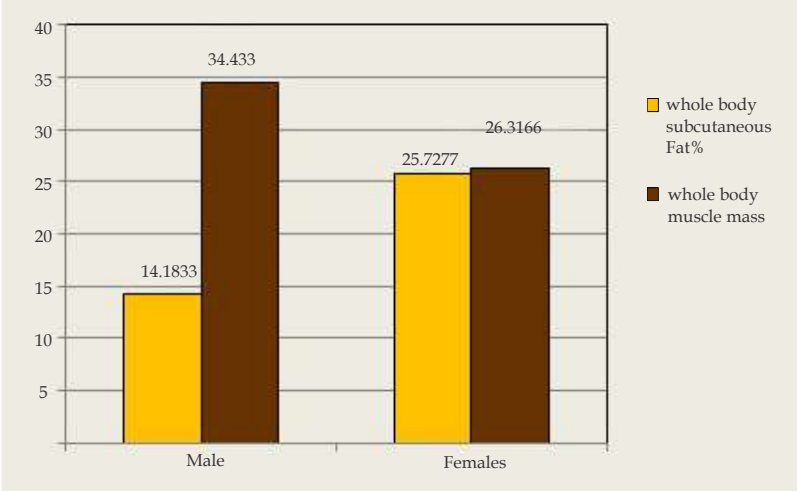

Fig. 2: Comparison of whole body subcutaneous fat % and muscle Mass% between male and female subjects

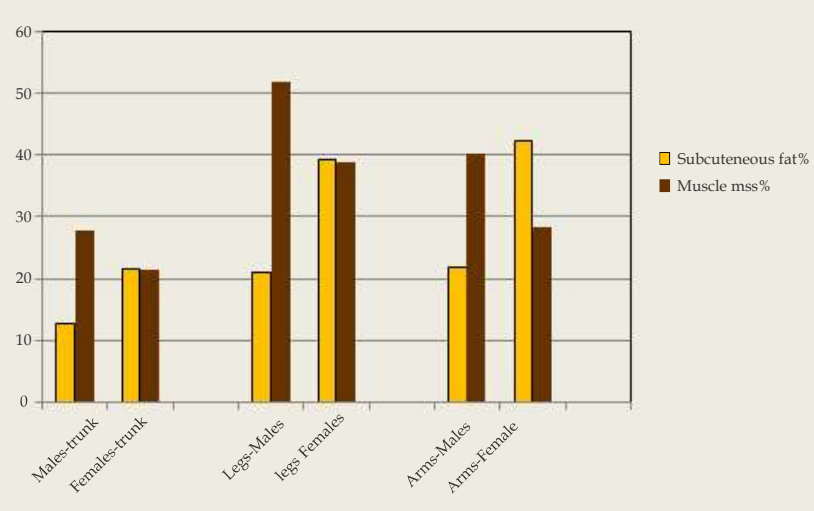

Fig. 3: Comparison of regional distribution of fat and muscle mass among male and female subjects

Discussion

The present study conducted on non-obese 130 medical student (50 Males and 80 Females) of *18 years of age*. We found that the total body fat% was more in the females when compared to males though there is no much difference in their BMI. It is also found that the visceral fat% of males is more than in females. When the regional distribution of muscle mass and subcutaneous fat% is compared, overall muscle mass in males is more than females and *i.e*., more pronounced in their lower limbs. When it comes to subcutaneous fat% female subjects showed more amount of subcutaneous fat than males and this difference in percentage is more pronounced in the upper limbs.

According to the diagnostic accuracy of BMI to detect body adiposity diminishes with increase in age of the person[4] but our study on the subjects of same age to avoid above said dilemma. Pasco *et al.* in their population study mentioned that BMI markedly under estimate adiposity in young men (aged 20–29). If only BMI is used to assess obesity one may not distinguish the contributions of fat and muscle mass to the total body weight, as the non-fat tissues have greater densities than fat, BMI may overestimate adiposity in muscular and lean body builds.[3]

Ethnicity influences were also there on the body fat% and South Asians have more body fat% as stated by Ranasinghe *et al.* in their research, even our present study also showed that body fat% is more when compared to BMI. Their study also showed in females body fat% is significantly more than male counterparts, which is in consistency with our study.[8] In this present study we have included subjects of same age group to avoid age wise changes in the body composition as explained by Havagiray R chitme et al in their study among college students about body fat distribution. Even our present study similar pattern of body fat distribution is found in the students.[2] In our study we have studied regional distribution of fat in both male and female students and compared the patterns as mentioned in the results.

Conclusion

In female subjects the BMI appears to be less but body fat% is significantly more which opposite in males. In males though their body fat% is significantly less than females, their visceral fat% is significantly more.

Keeping these findings in mind one should not consider BMI as only parameter to assess degree of obesity but body fat% and gender differences in its distribution also be taken in to account.

References

1. Dilek B. Compatibility of different methods for the measurement of visceral fat in different body mass index strata. Diagnostic and Interventional Radiology. 2010;16:99–105.
2. Havagiray R Chitne. Body fat distribution among college students. EC pharmacology and toxicology. 2018;6(6):445–54.
3. Julie A Pasco. Body mass index and measures of body fat for defining obesity and underweight: A cross sectional, population-based study. BMC obesity 2014; 1:9
4. Kanehisa and fukunaga. Association between body mass index and muscularity in healthy older Japanese woman and men. Journal of physiological anthropology. 2013 March; 32(1):4.
5. Deurenberg-yap M, Schmidt G, Van Staveren W A, *et al.* The paradox of low body mass index and high body fat percentage among Chinese, Malays and Indians in Singapore. International Journal of Obesity. 2000;24:1011–17.
6. Deurenberg P. The impact of body build and relationship between body mass index and percent body fat. International Journal of Obesity. 1999;23:537–42.
7. Manganhttps P. D://medium.com/the-mission/body-fat-is-more-important-than-body-mass-index.
8. Ranasinghe. Relationship between body mass index (BMI) and body fat percentage, estimated by bioelectrical impedance, in a group of srilankan adults: A cross sectional study. BMC Public health. 2013;13:797.
9. WHO https://www.who.int/en/news-room/fact-sheets/datail/obesity-and-overweight.
10. WHO: http://www.searo.who.int/entity/noncommunicable diseases/media/non communicable diseases obesity.

Original Article

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A Morphometric Study of Acromion Process of Scapula in Telangana Region

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Abstract

Introduction: The anatomy of the acromion varies considerably from individual to individual, and certain acromial shapes have been associated with an impingement syndrome. Neer's theory of impingement was further boosted by Nicholson who stated that a higher incidence of rotator cuff tears was present in patients with Bigliani Type III acromion (Hook Type). *Objectives:* (1) To study the morphometric features of acromion process of scapula (Type, Tength, Tidth and Thickness). (2) To compare the morphology of acromion process and morphology of scapula with those of previous studies. *Materials and Methods:* The study includes 60 dry scapulae out of them, 30 are of right and 30 are of left side. Only bones with clear and intact features were used for the study while damaged scapulae were excluded. The bone belongs to mature specimens, but the exact ages and gender of the specimens were not known. Descriptive statistics and correlation were calculated using SPSS 20 version. *Results:* The mean length, width, and thickness of acromion process of scapulae were 41.4 mm, 24 mm and 8.2 mm respectively. We found Type I and Type II acromion process were more in the Telangana region i.e., 46.66% and 38.34 % respectively. The Type III acromion process were 15%. *Conclusion:* In the present study we found Type I and Type II acromion processes were more in number in the Telangana Region with a very low incidence of Type III acromion process.

Keywords: Neer's theory of impingement; Bigliani Type III acromion.

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Introduction

Abduction of the arm may pinch the supraspinatus muscle between the head of the humerus and the arch created by the acromion and the coracoacromial ligament. The anatomy of the acromion varies considerably from individual to individual, and certain acromial shapes have been associated with an impingement syndrome.[1] Rotator cuff impingement syndrome is a painful disorder which is thought to arise from repetitive compression or rubbing of the tendons (mainly supraspinatus) under the coracoacromial arch.[2]

Codman in 1931 was the first to note that many patients with inability to abduct the arm had incomplete or complete ruptures of the supraspinatus tendon, rather than primary bursal problems. In 1972, Neer described impingement syndrome. Neer also noted that the anterior third of the acromion and its anterior lip seemed to be the offending structure in most cases. Acromion morphology has been implicated as contributing to impingement. Bigliani, Morrison and April described three types of acromion morphology and noted an increase in rotator cuff tears with Type III or hooked acromions. In a cadaver study of 140 shoulders, one third had full-thickness tears of the rotator cuff, 73% of which were in shoulders with Type III acromions.

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Neer describes the impingement into intrinsic and extrinsic types. The intrinsic impingement includes the thickening of the rotator cuff, calcium deposits within the rotator cuff, and the thickening of the subacromial bursa. The extrinsic impingement occurs when the space available for the rotator cuff is diminished; examples include subacromial spurring, acromial fracture or pathological osacrominale, osteophytes off the undersurface of the acromioclavicular joint, and exostoses at the greater tuberosity. Other investigators have suggested that the acromion shape and the coracoacromial ligament are not the primary problems. Codmon, Ozaki *et al.*, Sarkar and Uhthoff, and Ogata and Uhthoff suggested that intrinsic rotator cuff degeneration is the primary cause with subacromial changes occurring secondarily. Based on the observations by Neer, Bigliani *et al.,* and others, the recommended treatment for impingement syndrome has been anterior acromioplasty to remove the offending structure.[3]

Neer's theory of impingement was further boosted by Nicholson who stated that a higher incidence of rotator cuff tears was present in patients with Bigliani Type III acromion (Hook Type). Recently, Wang *et al.* concluded that patients with Bigliani Type II and III acromion are poor responders for conservative treatment.[4]

Objectives

1. To study morphometric features of the acromion process of scapula (type, length, width and thickness).
2. To study morphometric features of scapula (length and width).
3. To measure Acromio-glenoid and Acromio-coracoid distance.
4. To compare the morphology of acromion process and morphology of scapula with those of previous studies.

Materials and Methods

The study was performed at the department of Anatomy, Kamineni Institute of medical sciences, Narketpally, state Telangana (India).

The study includes 60 dry scapulae out of them, 30 are of right and 30 are of left side. Only bones with clear and intact features were used for the study while damaged scapulae were excluded. The bone belongs to mature specimens, but the exact ages and gender of the specimens were not known. We measured the length, width and thickness of the acromion process of scapula, length and width of the scapula, Acromio-glenoid and Acromio-coracoid distance. The mean of these parameters was found out and correlated.

The measurements are done by using vernier caliper. Ethical approval was taken for the research study from ethical committee of the institution. Descriptive statistics (mean ± SD) and correlation were calculated using SPSS 20 version. The morphometric values of the sides were analyzed using an unpaired *t*-test. Statistical significance was set $p \leq 0.05$.

The scapular parameters:

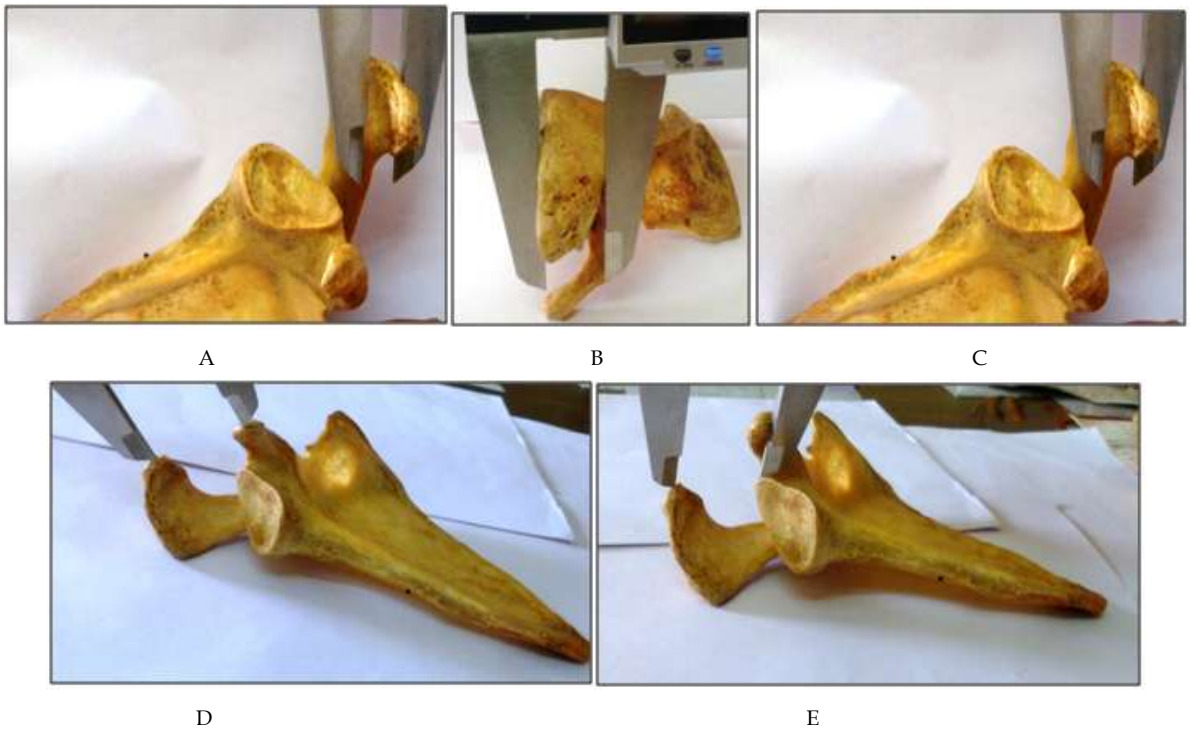
- *Maximum length*: is the maximum longitudinal diameter between the superomedial and inferior angle.
- *Maximum width*: is the maximum transverse diameter between the medial border of the scapula, where the spine meets the body of the scapula and the anterior lip of the glenoid (shown in **Figs. 1A and B**).

A B

Figs. 1A: L-Maximum length of scapula B. W-Maximum width of scapula

The acromion parameters:

- *Maximum length*: is the distance between tip and midpoint of posterior border of acromion process.
- *Maximum breadth*: is the distance between the lateral and medial borders at the midpoint of the acromion process.
- *Thickness*: is 1 *cm* behind the anterior border and 1 *cm* medial to the lateral border.
- *The Acromio-coracoid distance*: is the distance between both tips of acromion and coracoid processes.
- *The Acromio-glenoid distance*: is the distance between tip of acromion process and supraglenoid tubercle. **Figs. 2A to E** are given bellow:



A B C D E

Figs. 2A. Length of the Acromion process **B.** Width of the Acromion process **C.** Thickness of the Acromion process D. Acromio-coracoid distance **E.** Acromio-glenoid distance

The acromial type was classified according to Bigliani *et al.* (1986). Type I represents a flat, Type II a curved, and Type III a hooked undersurface of the acromion process of the scapula.[5] (Shown in **Fig. 3A to C**).

The descriptive statistics (Mean ± SD) and correlation were calculated using SPSS 20 version. The morphometric values of the sides were analyzed using an unpaired t-test.

A B C

Figs. 3A to C:

Results

In the present study we found the mean value of length of scapulae was 134.5 *mm* while it was 133 *mm* in right side and 136 *mm* in left side scapulae. The mean value of the width of scapulae was 98.8 *mm* whereas it was 99.6 *mm* in right side and 98 *mm* in left side scapulae. A summary of measurements regarding scapula and acromion process were shown in **Table 1 and 2**.

The mean length, width, and thickness of acromion process of scapulae were 41.4 *mm*, 24 *mm* and 8.2 *mm* respectively. The mean length, width, and thickness of acromion process of right side scapulae were 41.5 *mm*, 24.3 *mm* and 8.5 *mm* respectively. The mean length, width, and thickness of acromion process of left side scapulae were 41.4 *mm*, 23.6 *mm* and 7.9 *mm* respectively.

Table 2 shows; The length of the scapula is in positive correlation with the length of acromion process of scapula and it is significant. The width of the scapula is in positive correlation with the width of acromion process of scapula and it is significant.

The mean Acromio-coracoid distance and Acromio-glenoid distance were 36.5 *mm* and 27.2 *mm*. **Table 2 shows**; Acromio-coracoid distance and Acromio-glenoid distance is in positive correlation and are significant.

Table 1: Descriptive statistics of various parameters of scapulae

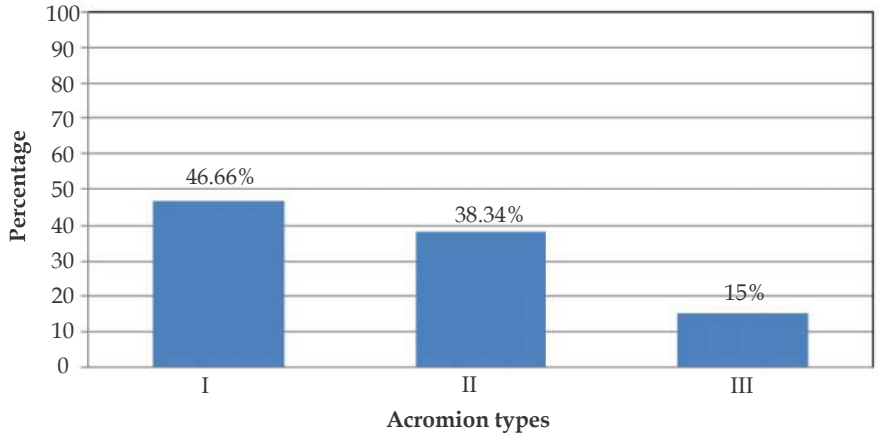
Parameters	Mean ± S.D Right Scapula (*mm*)	Mean ± S.D Left Scapula (*mm*)
Length of Scapula	133.0 ± 10.6	136.0 ± 10.1
Width of Scapula	99.6 ± 7.2	98.0 ± 8.1
Length of Acromion process	41.5 ± 3.6	41.4 ± 5.1
Width of Acromion process	24.3 ± 3.2	23.6 ± 3.1
Thickness of Acromion Process	8.5 ± 1.4	7.9 ± 1.0
Acromio-coracoid distance	37.8 ± 6.2	35.1 ± 2.9
Acromio-glenoid distance	28.2 ± 4.7	26.1 ± 3.8

Table 2: Correlation between various parameters of scapulae

Parameters	Mean ± S.D	*r* value	*p* value
Length of Scapula	134.5 ± 10.4	0.652**	0.000*
Length of Acromion process	41.4 ± 4.4		
Width of Scapula	98.8 ± 7.6	0.450**	0.000*
Width of Acromion process	24.0 ± 3.1		
Acromio-coracoid distance	36.5 ± 5.0	0.564**	0.000*
Acromio-glenoid distance	27.2 ± 4.3		

* *p* value is significant at ≤ 0.05.

**Correlation is significant at the 0.01 level (2-tailed).



Graph 1: Showing percentage of Types of Acromion process of Scapula

We found Type I and Type II acromion process are more in the Telangana region *i.e.*, 46.66% and 38.34 % respectively. This study shows Type I, Type II and Type III acromion process were 46.66%, 38.34%, and 15% respectively (**Graph 1**).

Discussion

We found the mean value of scapular length as 134.5 *mm* whereas Chandani Gupta *et al.* reported this mean as 139.3 *mm*, in another study by VVael Amin *et al.* in egyptian population found it as 151.16 *mm*. The mean value of scapular length is more in egyptian population, that may be due to population variation. G Paraskevas *et al.*, Jaskaran Singh *et al.* found the mean scapular length as 147.6 *mm* and 145.1 *mm* respectively.

The mean value of scapular width was found 98.8 *mm* in total scapulae, whereas Chandni Gupta *et al.*, G Paraskevas *et al.*, Jaskaran Singh *et al.* and VVael Amin *et al.* found this value as 101.4 *mm*, 101.9 *mm*, 105.5 *mm* and 107.22 *mm* respectively (**Table 3**).

In present study the mean value of length of the acromion process of right scapulae was 41.5 *mm* and left scapulae was 41.4 *mm*. So the length of the acromion process in right scapulae and left scapulae is nearly same. But Jaskaran Singh *et al.* found that the right acromion process was longer than left by 0.80 which was also found to be insignificant. We found the mean value of the length of acromion process as 41.4 *mm* while Chandni Gupta *et al.*, Jaskaran Singh *et al.*, G Paraskevas *et al.*, and VVael Amin *et al.* observed it as 42.1 *mm*, 46.1 *mm*, 46.1 *mm*, and 52.33 *mm* respectively.

The mean value of the width of acromion process in present study is 24 *mm*. Chandni Gupta *et al.* also found mean value of the width of acromion process as 24.2 *mm*. So this mean value of the width of acromion process in present study is nearly similar as found by Chandni Gupta *et al.*, G Paraskevas *et al.*, Jaskaran Singh *et al.* and VVael Amin *et al.* observed the mean value of width of acromion process as 22.3 *mm*, 23.2 *mm* and 32.09 *mm* respectively (**Table 3**).

Table 3: Morphometric parameters of scapula and acromion process observed by different authors

Sl. no.	Study	Parameters in *mm*						
		Length of scapula	Width of scapula	Length of acromion process	Width of acromion process	Thickness of acromion process	Acromio-coracoid distance	Acromio-glenoid distance
1	G Paraskevas[6] 2008 (Greek)	147.6	101.9	46.1	22.3	8.8	28.1	17.7
2	Jaskaran Singh[7] Sept. 2013 (India)	145.1	105.5	46.1	23.2	6.60	37.5	27
3	Chandni Gupta[8] Sept. 2014 (India)	139.3	101.4	42.1	24.2	7.3	30.9	24.7
4	Vvael Amin[9] Aug. 2015 (Egypt)	151.16	107.22	52.33	32.09	9.11	31.10	27.11
5	Present Study (India)	134.5	98.8	41.4	24	8.2	36.5	27.2

Chandni Gupta *et al.* found the mean value of the thickness of acromion process as 7.3 *mm* in right side scapula and 7.4 *mm* in left side scapula. In the present study the mean value of thickness of acromion process is 8.5 *mm* in right side scapula and 7.9 *mm* in left side scapula. Jaskaran Singh *et al.* found the mean value of the thickness of acromion process as 6.6 *mm* in right side scapula and 6.7 *mm* in left side scapula.

Jaskaran Singh *et al*, VVael Amin *et al.* found the acromio-coracoid distance on the right and left side scapulae as 37.1 *mm*, and 37.9 and 31.1 and 31.58 *mm* respectively. Chandni Gupta *et al* found the mean value of acromio-coracoid distance on the right and left side scapulae as 31.8 *mm* and 30.3 *mm* respectively. In the present study the mean value of acromio-coracoid distance was observed as 37.8 *mm* and 35.1 *mm* in right and left side scapulae respectively (**Table 3**).

Jaskaran Singh *et al*, VVael Amin *et al* found the mean value of acromio-glenoid distance on the right and left side scapulae as 26.6 *mm* and 27.6 *mm* and 27.11 *mm* and 27.67 *mm* respectively. In the present study the mean value of acromio-glenoid distance was observed as 28.2 *mm* and 26.1 *mm* in right and left side scapulae respectively. Chandni Gupta *et al. found* the mean value of acromio-glenoid distance

in the right and left scapulae as 25.3 *mm* and 24.3 *mm* respectively (**Table 3**).

Jaskaran Singh *et al.* examined the three Types of acromion. Type I (flat) was seen in 22.5%, Type II (curved) in 38.8%, and Type III (hooked) in 38.8% of total samples. Chandni Gupta *et al.* found the distribution of acromial type as Type I - 32 %, Type II - 22 %, and Type III - 46%. Shilpa Gosavi *et al.* found the distribution of acromial Type as Type I - 13.3 %, Type II - 81.88 %, and Type III - 4.7 %.[10] VVael Amin *et al.* found the distribution of acromial type as Type I - 26.88%, Type II - 45.62%, and Type III - 15%. G Paraskevas *et al.* found the distribution of acromial type as Type I - 26.1%, Type II - 55.6%, and Type III - 18.1%.Schippinger G *et al.* investigated anatomy of acromion using MRI and they found the distribution of acromial Type as Type I - 67.7 %, Type II - 32.3 and Type III acromion were not found.[11] In the present study high incidence of acromial Type I - 46.66%, followed by Type II - 38.34%, and very low incidence of acromial Type III - 15% was observed (**Table 4**).

In the present study high incidence of acromial Type I - 46.66%, followed by Type II - 38.34%, and very low incidence of acromial Type III - 15% was observed.

Table 4: Types of acromion processes found by different authors

Sl. no.	Study	Types of Acromion Process		
		I	II	III
1	G Paraskevas[6] 2008 (Greek)	26.1	55.6	18.1
2	Jaskaran Singh[7] Sept 2013 (India)	22.5	38.8	38.8
3	Chandni gupta[8] Sept 2014 India)	32	22	46
4	Vvael Amin[9] Aug 2015 (Egypt)	26.88	45.62	15
5	Present Study (India)	46.66	38.34	15

Conclusion

In the present study we found Type I and Type II acromion processes were more in number in the Telangana region with a very low incidence of Type III acromion process. The length and width of scapula were in positive correlation with the length and width of acromion process of scapula. Acromio-coracoid distance and Acromio-glenoid distance was also in the positive correlation. This data on various distances of acromion process may be helpful to the orthopaedicians during surgical repair around the shoulder joint. The morphometric analysis of the acromion process may be used like an auxiliary to promote a better knowledge about the diseases that appear in the Telangana region.

Conflicts of interest: None

References

1. Hoppenfeld S, DeBoer P, Buckley R. Surgical Exposures in Orthopaedics: The anatomic approach, 4th editor. Wolterskluwer: Lippincott Williams and Wilkins pub; p.43.
2. Solomon L, Warwick D, Selvadurai NS. Apleys System of Orthopaedics and Fractures, 9th edition. Hodder Arnold-An Hachette UK company; p.341.
3. Terry Canale S and James H Beaty. Campbell's Operative Orthopaedics, Volume 3, 11th edition. International edition: Mosby Elsevier; pp.2609–610.
4. Kulkarni GS, Babhulkar S. Textbook of Orthopaedics and Trauma, Volume 3, 3rd edition. Jaypee pub; p 2110.
5. Bigliani LU, Morrison DS, April EW. The morphology of the acromion and its relationship to rotator cuff tears. Ortho Trans. 1986;10:228.
6. Paraskevas G, Tzaveas A, Papaziogas B, *et al.* Morphological parameters of the acromion. Folia morphol. 2008;67(4):255–60.
7. Singh J, Pahuja K, Agarwal R. Morphometric parameters of the acromion process in adult human scapulae. Indian Journal of basic and applied Medical Research. 2013 Sept;2(8):1165–170.
8. Gupta C, Priya A, Guruprasad KS, *et el*. A morphometric study of acromion process of scapula and its clinical significance. CHRISMED Journal of Health and Research. 2014 Jul–Sept: 1(3):164–69.
9. Amin VVael Amin Nast El-Din and Ali Mona Hassan Mohammed. A morphometric study of the patterns and variations of the acromion and glenoid cavity of the scapulae in Egyptian

population. Journal of Clinical and Diagnostic Research. 2015 Aug;9(8)AC08–AC11.

10. Gosavi S, Jadhav S, Garud R. Morphology of Acromion process: A study of Indian scapulae. International Journal of Pharma Research and Health Sciences. 2015;3(5):831–35.

11. Schippinger G, Bailey D, McNally EG, Kiss J, Carr AJ. Anatomy of the normal acromion investigated using MRI. Langenbecks Arch Chir. 1997;382(3):141–44.

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Perception of Students on Various Formats of Written Assessments in Education

Sonali B Kankhare[1], Anjali D Patil[2], Bhiku H Bahetee[3]

Abstract

Introduction: Assessment **i**s crucial to the educational process, and is useful that in assessing the knowledge. At under graduate level there are three domains of skill to be evaluated, a cognitive, affective, and psychomotor. The written assessment are to be done with the help of **MCQ**, **SAQ**, **LAQ** (open ended) essay writing. *Aims:* To assess the preferences of undergraduate medical student among the three formats of written assessment: LAQ, SAQ and MCQ. *Settings and Designs:* A cross sectional study was conducted on 100 students of first MBBS for the duration of four month from December 2016 to March 2017 at BJGMC. Pune. After the completion of lecture series exam was conducted and performance was assessed. Statistical analysis done and percentage was calculated. *Results:* 90% students would like to have MCQs in their regular exam. Student with strong factual and recalling ability, they opted for the MCQs. But the students with strong analytical or interpretative skill and those can apply knowledge they opt out for SAQ and LAQ. *Conclusion:* It should be combination of various methods and techniques assessment is based upon purpose of evaluation at various levels in the form of skill, knowledge and understanding.

Keywords: Assessment; Learning; Medical education.

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Introduction

Assessment is a need of educational system and is useful in gaining and judging the knowledge. It provides feedback to teachers and learners.[1] At undergraduate level there are three domains of skill to be evaluated, a cognitive, affective and psychomotor. As medical education mainly consists of diagnosis and treatment of diseases so, it should be based on developing and evaluating the level 3 or problem solving skill. Learning progress and assessment of progress are the major events in the curriculum which go hand in hand. Assessment of student can be carried out by means of theory, practical and clinical eand case studies.

Assessment of student carry wonderful role in students curriculum. *E.g.*, To test the knowledge of student, to give feedback to the students as well as teachers and to evaluate the effectiveness of learning and teaching. As the assessment of student has direct influence on teaching methodologies, teacher can modify the technique to improve the medical education. Assessment of student is important to check the competency of student hence it is consider as valid tool. The written assessment are to be done with the help of MCQ, SAQ, LAQ (open ended) essay writing. Open ended questions are descriptive, structured and these questions are helpful in testing the higher order thought process and interpretation of skill. Descriptive questions are in the form of LAQ, SAQ and modified essay questions or MEQ.

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Learning is a continuous process in which knowledge is gain.[2,3] Assessment of knowledge is made by written and practical examination. The test and questions for written examination is based on the application of knowledge. The assessment of knowledge is necessary to improve the performance.[4]

MCQs

The multiple choice question tests is an assessment which can be used to measure knowledge, abilities, thinking skills, etc. There are various forms of MCQs. *e.g*. Single or one best option' type, 'True or False', 'Multiple true or False', Matching' and the 'Extended matching' type questions. Setting of problem based MCQs is very difficult but it is more effective to assess the levels of knowledge.[5,6] The main advantages are that they can be written easily and cover a wide range of topic. Diagnosis of complicated clinical cases can be assessing with newer formats of MCQ. The multiple-choice format has had many distracters. MCQs are closed-ended questions which do not stimulate cognitive thought processes.[7,8]

LAQ

Long answer questions are unstructured, used for assessment of complex teaching. Main reason behind LAQ is to assess deeper knowledge of topic, understanding of subject as well as we can assess their writing skills. There is scope for creativity.

SAQ

SAQ or structured questions are directed towards the specific answer. These questions are used to test the knowledge as well as analysing, reasoning, integration and interpretation ability of student.[9]

Modified essay questions asses the approach of student to solve the problem, their understanding and interpretation of concepts. Modified essay question broadly measure higher cognitive skill of students, as well as absolute knowledge retained by students and application of that knowledge while evaluating clinical problem.[10]

Aims and Objectives

To assess the preferences of undergraduate medical student among the three formats of written assessment: **LAQ**, **SAQ** and **MCQ**.

Materials and Methods

A cross sectional study was conducted among first year undergraduates students of medicine for the duration of four month from December 2016 to March 2017. The purpose of study was explained in detail to students and informed consent was taken. As lecture series were over, we had conducted the test for duration of two hours. Questions were asked in three different formats (LAQ, SAQ, and MCQ). The main purpose of conducting test was not only to assess their performance but also to expose them to all the three modalities of questions which help them to answer the questionnaire. After the data collection, it was entered in excel sheet and analysed by using appropriate method.

Results

In our study, 200 first year undergraduate students were allowed to participate. After evaluation of feedback form we got following information:

90% students liked pattern of MCQ and SAQ.

60% prefer MCQ over SAQ.

76% student said that pattern of studies were different for MCQ and SAQ.

90% students would like to have MCQs in their regular exam.

Student with strong factual and recalling ability, they opted for the MCQs.

But the students with strong analytical or interpretative skill and those can apply knowledge they opt out for SAQ and LAQ.

Feedback from students

SAQ

Here, students have to think and then decide about answer, in this pattern they can write point to point on particular topic and they can obtain good marks within short period of time. No need to read entire topics or if they write something they will get minimum marks.

MCQ

They have to read the entire chapter and no need to mug up understands the concept is most important while solving MCQ. MCQ are easier and faster to answer. It is easy to choose the correct answer, instead of remembering each and every thing

about the topic. And if someone does not know the answer; he/she can tick anywhere, so it is luck dependent. Handwriting and grammatical errors does not matter.

LAQ

They have to mug up entire chapter. Handwriting, drawing and presentation matter. Teachers can be biased while examining the papers so scoring is very difficult. The data obtained from feedback filled by the students was analysed and tabulated.

Suggestions given by students

As in our exam pattern we did not include the modified essay question or the questions in the form of case studies, Student demanded questions which are focussed on problem based learning/ case studies to develop their clinical knowledge and ability to solve the case and to judge the diagnosis and treatment which will be helpful for them while doing clinical practice in future. Some students gave opinion that since they are facing the post graduate entrance test; college/examiner should keep only MCQ as a pattern. (Shown in **Table 1**)

Table 1: Analysis of data

Sl. no.	Questions	MCQ	SAQ	LAQ
1	Which type of question do you prefer to write answer?	60	30	10
2	Which type of question cover more spectrum of content?	10	40	50
3	Which type of question can test your knowledge of topic?	20	40	40
4	Which type of question can test your presentation skill in your exam?	5	45	55
5	Which type of question test can test your clinical knowledge and skill?	10	25	65
6	Which type of question removes teacher bias during assessing your paper?	80	18	22
7	Which type of question save your time while writing paper?	70	25	5
8	Which type of question give you more mark?	55	25	20

Discussion

After an analysing the feedback forms, it was observed that students give more preference to MCQ based tests. It is easier to score MCQ than written exams of long and short essay type questions. In written exam it is difficult to express their answers in words. They do not realise which points to be have stressed more while writing essay type questions. Some students have bad hand writing while some students find it difficult to express their answers in English as it is not first language for them during their school period. There are certain disadvantage for the theoretical written assessment test have like cramming for examinations and acquiring superficial knowledge rather than understanding the concept in depth.[11] There will be the chances of subjective bias while assessing theory papers.[12] A short answer question (SAQ) is similar to a well-stated MCQ without the alternatives. These open-ended questions are more flexible in testing creativity and spontaneity. To write an answer of open-ended SAQs is much more time-consuming than answering MCQs. However, these have lower reliability. Essays are ideal to assessing ability of students to summarize, to hypothesize, to find relations and apply knowledge on new situations.[6] A good open-ended question should include a detailed answer key for the person marking the paper.[9]

When constructing essay questions, it is essential to define the criteria on which students can write answer. Essay-type questions are time-consuming and take a long-time for evaluation. The other methods of written assessment that have been used in the past include modified essay questions (MEQs) and patient management problems (PMPs) to test problem-solving and decision-making skill. The use of both MEQs and PMPs encourage more complex thinking skill and help to develop problem solving skills.[10] Lukhele *et al.* studied a number of examinations which included both multiple choice items and essay questions. They found that multiple-choice items provided the same amount of information as a single essay. Multiple-choice format has a clear advantage over open-ended formats in terms of reproducibility, ability to test higher-order cognitive skills.[13] To construct multiple-choice assessment is more difficult and labour-intensive, but once the question bank has been developed from which questions can be drawn for re-use. Essay-type questions, SAQ and their variants test higher-order cognitive thinking. MCQ format is not able to test deep learning, and is suitable for assessing superficial facts, whereas

open ended questions assess dynamic cognitive processes.[7] Palmer and Devitt analysed a large number of multiple-choice and MEQ questions used for summative assessment in a clinical undergraduate exam students are not only recalling but also he using his higher cognitive skill.[9] Norcini *et al.* found that written patient management problems and multiple choice items appeared to be measuring essentially the same aspects of clinical competence.[1] Moquattash *et al.* concluded long easy type is sensitive where students are not only recalling but also he using his higher cognitive skill.[14]

Conclusion

Each domain can be assessed by various methods. So Assessment of learner cannot be done by single method, it should be based upon purpose of evaluation at various level in the form of skill, knowledge and understanding. Combination of various forms in the same assessment, it improves the strength of the assessment.

Conflict of Interest: None

Abbreviations:

LAQ: Long answer question

SAQ:Short answer question

MCQ: Multiple choice question

MEQ:Modified essay question

References

1. Norcini JJ, Swanson DB, Grosso LJ, *et al.* Reliability, validity and efficiency of multiple choice question and patient management problem item formats in assessment of clinical competence. Med Educ. 1985 May;19(3):238–47.
2. Siemens G. Connectivism: Learning as Network—Creation [http://www.elearnspace.org/Articles/ network.htm]
3. Siemens G. Connectivism: A learning theory for the digital age. Int J Instr Technol and Distance Learn. 2005;2:3–10.
4. Norcini JJ. Work based assessment BMJ. 2003 April 5;326(7392):753–55.
5. Schuwirth LW, Van der Vleuten CP. Different written assessment methods: What can be said about their strength and weakness? Med Edu. 2004 Sept;38(9):974–79.
6. Schuwirth LW, Van der Vleuten CP. ABC of learning and teaching in medicine Written assessment. BMJ. 2003 Mar 22;326(7390):643–45.
7. Haladyna TM, Downing SM, Rodriguez MC. A review of multiple choice item writing guidelines for classroom assessment Applied Meas Edu. 2002;15(3): 309–34.
8. Stratford P, Pierce-Fenn H. Modified essay question. Phys Ther. 1985;65:1075–79.
9. Palmer EJ, Devitt PG. Assessment of higher order cognitive skills in undergraduate education; modified essay or multiple choice questions. Research paper BMC Med edu. 2007 Nov 28;7:49.
10. Rotfield H. Are we teachers or job trainers? Acad Mark Sci Q. 1998;2(2).
11. Kaufman DM. Applying educational theory in practice. BMJ. 2003 Jan 25;326(7382):213-16.
12. Albanese M. Rating educational quality: factors in the erosion of professional standards. Acad Med. 1999 Jun;74(6):652–58.
13. Lukhele R, Thissen D, Wainer H. On the relative value of multiple–choice, constructed responses, and examinee-selected items on two achievement tests. J Edu Meas. 1994;31(3):234–50.
14. Monqattash S, Harris PF, Gumna KA, *et al.* Assesment of basic medical science in an integrated system based curriculum, Clin Anat. 1995;8(2):139–47.

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Study of Variations in the Bifurcation of Brachial Artery in Andhra Pradesh Population

Sujana Arani[1], Makandar UK[2]

Abstract

32 male cadavers were selected to study the variation of bifurcation of brachial artery. Measurement were taken from (a) tip of the Acromion process of scapula to tip of the middle finger (b) Position of brachial artery was measured from epicondyle of humerus to the point of bifurcation of brachial artery. All the measurements were taken by tailors tape. The mean value of length right upper limb was 73.66 (SD ± 0.38) and mean length of point of brachial artery from epicondyle of Humerus was 4.29 (SD ± 0.01) and mean value of length left upper limb was 73.61 (SD ± 0.35) and point bifurcation of artery mean value was 4.28 (SD ± 0.02), correlative co-efficient study of upper limb was 0.73, '*t*' test value was 5.8 and '*p*' value was highly significant (p <0.01) of left limb was 0.84 '*t*' test value was *t*.84 and *p* value was highly significant (p <0.01). This study was quite helpful to orthopedic surgeon, physician to predict the point of bifurcation by knowing length of upper limbs and *vice versa*, so that they can preserve the brachial artery and its branches and take proper use like pulsation or recording blood pressure.

Keywords: Brachial artery; Olecranon process; Acrimony process.

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Introduction

As Brachial artery is continuation of axiliary artery beyond the lower border of the Teresmajor muscle usually it divides opposite to the neck of the radius in anterior cubital fossa as radial and ulnar Artery.[1,2] As the ulnar artery is longer and deeper begins a little below the bend of the elbow and passing oblique down wards reaches the flexor carpi ulnaris muscle in its middle third and takes part in superficial and deep palmar arches. The radial artery is smaller in caliber than ulnar it passes along the radial side of the foramen to the wrist takes parts in the completion of superficial and deep palmar arches.[3]

Brachial artery and its branches is important to avoid serious complication while arterio venous fistulae, aneurysm and abscess drainage in cubittal fossa and during amputation traumatic fracture, thrombo-obliterens.[4] In addition to this brachial artery is used to record blood pressure and brachial pulsation. Hence attempt was made to correlate the length of upper limb with position of bifurcation of artery in the cadavers.

Materials and Methods

32 (thirty two) male dissected cadavers preserved in the dissection hall were studied length of the right and left upper limb was measured. Tip of Acrimion process of scapula to the tip of the middle finger. Bifurcation of Brachial artery was measured from epicondyle of Humerus to bifurcation of brachial artery. These measurements were taken by Tailors

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tape.

The obtained findings were studied statistically by correlative co-efficient equation by SP Software of 2007.

The duration of this study was about three years.

Results

***Table 1*:** Average length of right upper limb and length position of bifurcation of brachial artery to epicondyle of humerus, mean value of length of right upper limb 73.66 (SD ± 0.38) and mean length of brachial artery from epicondyle of humerus was 4.29 (SD ± 0.38).

***Table 2*:** Average length of left upper limb and length of position of brachial artery, mean length left upper limb was 73.61 (SD ± 0.35) and mean length of position bifurcation brachial artery was 4.28 (SD ± 0.01)

Table 1: Average Length of Right upper limb and length of position of bifurcation of brachial Artery from Epicondyle of Humerus in Male cadavers.

No. of Cadavers-32

	Length of Right Upper Limb (*cm*)	Length of Position of Bifurcation of Right Brachial Artery
Mean	73.66	4.29
SD	0.38	0.01

Table 2: Average Length of Left upper limb and length of position of bifurcation of brachial Artery from Epicondyle of Humerus in Male cadavers.

No. of Cadavers-32

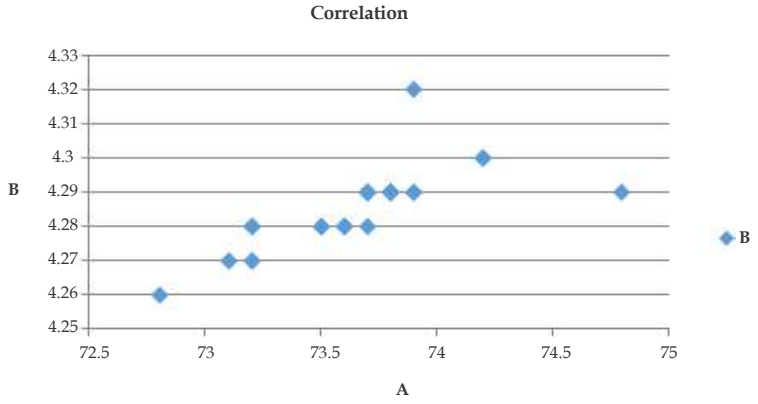
	Length of Left Upper Limb (*cm*)	Length of Position of Bifurcation of Left Brachial Artery
Mean	73.61	4.28
SD	0.35	0.02

***Table 3*:** Correlative co-efficient of length of right upper limb was 0.73 '*t*' test value was 5.8 and *p* value was lightly significant ($p < 0.01$).

***Table 4*:** Correlative co-efficient of length of left upper limb study was 0.84 '*t*' test value was 8.4 and *p* value was highly significant ($p < 0.01$).

Table 3: Correlative co-efficient of Length of Right upper limb with position of bifurcation of brachial Artery from Epicondyle of Humerus in Male cadavers.

	Length of Right Upper Limb (*cm*)
Correlation co-efficient	0.73
Test statistic	$t = 5.85$, $p < 0.01$



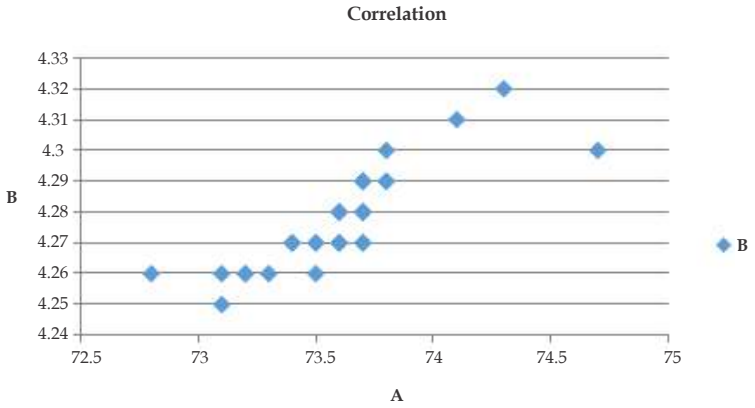
A: Length of Right Upper Limb (*cm*)

B: Length of Position of Bifurcation of Right Brachial Artery

Statistically highly significant positive correlation observed between Length of Right Upper Limb and Length of Position of Bifurcation of Right Brachial Artery ($p < 0.01$).

Table 4: Correlative co-efficient of Length of Left upper limb with position of bifurcation of brachial Artery from Epicondyle of Humerus in Male cadavers

	Length of Left Upper Limb (*cm*) Vs Length of Position of Bifurcation of Left Brachial Artery
Correlation co-efficient	0.84
Test statistic	$t = 8.47$, $p < 0.01$



A: Length of Left Upper Limb (*cm*)

B: Length of Position of Bifurcation of Left Brachial Artery

Statistically highly significant positive correlation observed between Length of Left Upper Limb and Length of Position of Bifurcation of Left Brachial Artery ($p < 0.01$).

Discussion

The present study of variation in the bifurcation of brachial artery in Andhra Pradesh population (cadaveric study). Mean value length of upper limb was 73.66 (SD ± 0.36) and mean length of position of bifurcation of brachial artery was 4.29 (SD ± 0.01) (**Table 1**)and mean length of left upper limb (UL was 73.61 *cm* (SD ± 0.35) and, mean length of position of bifurcation of Brachial artery 4.28 *cm* (SD ± 0.02) (**Table 2**) correlative co-efficient of length of right UL was 0.73 *t* test value was 5.85 and *p* value was highly significant ($p < 0.01$) (**Table 3**). Correlative co-efficient of length of left UL was 0.84 '*t*' test value was 8.47 and *p* value was highly significant ($p < 0.01$) (**Table 4**). These findings were more or less in agreement with previous studies. [5,6,7]

These variations could be due to the arterial system of the body seek shortest and most direct course to reach their objective that course is partly determined by mechanical convenience. The main arteries of the limbs run along the flexor surfaces where they are less likely to be exposed to tension in movement of the adjacent joints. They avoid passing through actual muscular tissue which would compress them during contraction. Hence they bifurcate to avoid tension created by joints and muscular contraction as well. Moreover the angle at which branches leave the main artery depends to considerable extent on hemodynamic pressure.[8]

In addition to that as brachial artery is muscular medium size artery. Hence it can be hypothesized that the muscular tissue in their walls enable them under the influence of autonomous nervous system.[9] Contract and dilate and so to regulate the distribution of blood to the areas which they supply and whenever there's more demand or more area to be supplied hence bifurcation might have occurred to meet the challenge of blood supply to larger areas.

This study of variation of bifurcation will be quite useful to internal arterio-venous fistulae was established in chronic renal failure for repeated vine puncture to access the blood stream.

Moreover following injury of arm particularly of the elbow joint injure to brachial artery. Hence bifurcation has surgical importance too.[10]

Conclusion

The present study of variation in the bifurcation of brachial artery will be useful to orthopedic surgeon, physician, cardiologist, radiologist and anatomist as well. But this study demands further genetic,

embryological, nutritional and bio-mechanical studies because exact mechanism of formation of angiogenic cells in fetal life is still unclear.

This research paper was approved by ethical committee Nimra Institute of Medical Science Ibrahim Patnam-521456 (Andhra Pradesh).

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References

1. Yalciri P, Kocabiyik. Arterial variation of the upper extremities, Anatomical Science International. 2006;81(1):62–4.
2. William PL, Bannister LH. Grays Anatomy cardio vascular system, 38th edition. New York: Churchill living stone; 1995.pp.1538–40.
3. Arunav vchil. A case report on high level bifurcation of brachial artery. Inter J Advances case reports. 2016;3(6):258–61.
4. Vishala AR, Rajashekar HV. Variation in the branching pattern of brachial artery. A morphological and statistical study. Int J Bol med Res. 2013;4(1):2920–923.
5. Gupta Hanuman Prasad, Rajendra R, Makandar UK, *et al*. Correlative study of length of upper limb with position bifurcation of brachial artery in males of Rajasthan population. Int J of center surg. 2016 July–Dec;4(2):22–24.
6. Deepa TK and Martin K John. An anatomical study of variation in termination of brachial artery. Embryological basis and clinical implication. Int J Med Res Health Sci. 2016;5(3):85–9.
7. Rajan K. Trifurcation of brachial artery: A case report. J Anat Soc India. 2001;50(2):163–65.
8. Murray CD. The physiological principle of minimum work applied to the angle of branching of arteries. J Gen Physiol. 1926 Jul 41-835:(6)9;20.
9. Lee Gross clark WE. The tissue of the body 6th edition. Oxford at the Clarendon Press; 1971. pp. 192–96.
10. Decker Gag, Plessis D J. du, Gregory Lee Mc. Synopsis of surgical anatomy. 12th edition. KM Varghese Co, Dadar Bombay: 14, India; 1986. pp.231–32.

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Study of Variations in the Position of Mental Foramen in Mandible in Andhra Pradesh Population

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Abstract

36 adult non-pathological dried mandibles were studied. Distance between Mental Foramen (MF) and symphysis menti on both sides was measured and compared. Mean value of right side were 27.2 *mm* (SD ± 0.28) and mean value of left side was 26.3 *mm* (SD ± 0.35) '*t*' test value was 15.0 and '*p*' value was highly significant ($p < 0.01$). Distance between MF and lower border of body of mandible was measured on both sides and compared, mean value of right side was 14.2 (SD ± 0.14) and left side was 13.2 (SD ± 0.26) '*t*' test value was 19.5 and '*p*' value was highly significant ($p < 00.1$). The distance between MF and posterior border of ramus of mandible was measured and compared. Mean value of right side was 9.2 (SD ± 0.21) and mean value of left side was 70.2 (SD ± 0.15), '*t*' test value was 22.5 and *p* value was highly significant (SD ± 0.01) All these measure me were taken by vernier caliper. Mandible form the floor and cavity for tongue, the carcinoma of tongue also spread to body and ramus of the mandible moreover during accident chin or symphysis menti was commonly fractured. Hence these parameters will be quite useful to maxilla-facial surgeon to preserve the mental nerve which is sensory supply to lower lip, the buccal mucosa from incisor to the premolars and skin over the chin. Mental nerve also carries chorda tympani to labial minor salivary glands.[1] It is also useful anesthetist to give local anesthesia invasive procedure for buccal or oral surgery. Moreover, these parameters belong to adult mandible who are more prone to meet accidents.

Keywords: MF = Mental foramen; ramus; body; symphysis menti; venier caliper.

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Introduction

Mental foramen (MF) situated on antero-lateral aspects of the mandible and transmits mental nerve and vessels.[2] As a branch of inferior alveolar nerve, the mental nerve exits from the mental foramen and provide sensory innervations to the lower lip gingiva and skin over the mental region. During the surgical procedures such as mandibular osteotomies, surgical removal of impacted teeth, apicectomy enucleation of cyst and excision of tumors the mental nerve can get damaged.[3] Causing functional and psychosocial problems over the region where it innervates. Compression, injury of the mental nerve can also occur while excessive stretching of nerve during surgical procedures, Iatrogenic damage of the nerve can occur during implant of placement.[4] Hence attempt was made to measure the various parameters of the mandible on both side and compared the same, so that it would be helpful to preserve the mental nerve and blood vessels passing through MF in above mentioned surgical procedures.

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Materials and Methods

(a) Thirty six dried, adult, non-pathological mandible were studied. The measurement was taken by vernier caliper.

(b) The distance between symphysis menti and mental foramen.

(c) Distance between lower border of body of mandible and mental foramen.

(d) The distance between posterior border ramus of mandible to mental foramen was measured. Measurement was taken on both sides of the mandible and compared statistically.

The broken and pathological mandibles were excluded from the study. The duration of study was about two year.

Results

***Table 1*:** Comparison of measurement between symphysis menti to mental foramen right and left–The mean value of right side distance was 27.5 (SD ± 0.28) and left side mean value was 26.3 (SD ± 0.25) '*t*' test value was 15.06 *p* value was highly significant (p <0.01).

Table 1: Comparison of measurement of distance between anterior margin of mental foramen to symphysis of mandible.

	Right anti border of mental foramen to symphysis menti (*mm*) (38) (A)	Left anti border of mental foramen to symphysis menti (*mm*) (38) (B)
Mean	27.25	26.32
SD	0.28	0.25
Test statistic	'*t*' = 15.06, $p < 0.01$	

Statistically right anterior border of mental foramen to symphysis of mandible is highly significant more than Left anterior border of mental foramen to symphysis menti of mandible ($p < 0.01$).

***Table 2*:** Comparison of measurement between inferior margin of mental foramen of mandible and lower border of mandible on both sides. Mean value of right side was 14.2 (SD ± 0.14) and left mean value was 13.2 (SD ± 0.26) and '*t*' test value was 19.3, *p* value was highly significant ($p < 0.01$).

Table 2: Comparison of measurement of distance between inferior margin of MF of mandible and Lower border of body of mandible.

	Right side	Left side
Mean	14.22	13.26
SD	0.14	0.26
Test statistic	$t = 19.55$, $p < 0.01$	

Statistically right side distance between inferior margin of MF of mandible and over border of body of mandible is highly significant more than left side distance between inferior margin of MF of mandible and Lower border of body of mandible ($p < 0.01$).

***Table 3*:** Comparison of measurement between inferior margin of mental foramen (MF) and posterior border of ramus of mandible. Mean value of right side 69.2 (SD ± 0.21) and mean value of left side was 70.2(SD ± 0.15) '*t*' test value was 22.5 and *p* value was highly significant ($p < 0.0.1$).

Table 3: Comparison of measurement of distance between posterior margin of mental foramina and post border of ramus of mandible.

	Right side	Left side
Mean	69.29	70.23
SD	0.21	0.15
Test statistic	$t = 22.52$, $p < 0.01$	

Statistically right side distance between posterior margin of mental foramina and post border of ramus of mandible is highly significantly less than left side distance between posterior margin of mental foramina and post border of ramus of mandible ($p < 0.01$).

Discussion

The present study of variation in the position of MF of mandible in Andra Pradesh population. Comparison of measurement of distance between MF and symphysis menti was on right side mean value was 27.5 (SD ± 0.28) and left side mean value was 26.3 (SD ± 0.25) '*t*' test value was 15.06 and *p* value was highly significant ($p < 0.01$) (**Table 1**). Comparison of measurement between inferior margin of MF and lower border of body of mandible on right side mean value was 14.2 *mm* (SD ± 0.14) and left side was 13.2 (SD ± 0.26) '*t*' test value was 19.5 and *p* value was highly significant ($p < 0.01$) (**Table 2**). Comparison of measurement between posterior margin of MF and poster or border of ramus of mandible on right side mean value was 69.2 *mm* (SD ± 0.21) and left side mean value was 70.2 (SD ± 0.15) '*t*' test value was 22.5 and *p* value was highly significant ($p < 0.01$) (**Table 3**). These values were more or less in agreement with previous studies.[5,6,7]

The variations in position of MF because MF usually situated below and between the position of the root apices of the premolar teeth because of the way mandible grows the opening of the MF usually points backwards in modern humans.[8] Moreover, bone is in two halves at birth and does

not fuse until a year or more has elapsed. The Meckels cartilage atrophies in its great part, but in the front portion, taken into the bone is ossified and probably therefore represented in the bone between body and symphysis.[9] A part from this, as proceeding of evolution has led to greater human brain and reduction of mandible has resulted into variations in the position of MF in different region and ethnicity.[10] It cannot be forgotten that, the skeleton of a particular individual is able to adapt to its owners way of life. In addition to this, intracellular rearrangement of materials and same extracellular agents such as hormones nutrition may play a role in promoting regional differention of mesodermal derivatives.

Conclusion

The present study variation in the position of MF of mandible is quite useful to Maxillofacial surgeon, oncological surgeon, anaesthesist, anthropologist and anatomist. But this study demands further genetic, embryological, nutritional, anthropological study because exact ossification mechanism and duration of formation, regression of symphsis menti is still unclear.

This research is approved by Ethical Committee Nimra Institute of Medical Science Ibrahim Patnam, Vijayawada (Andhra Pradesh).

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References

1. Decker Gorge, Plessis DJ du. MC Gregory's Synopsis Surgical Anatomy, 12th edition. KM Varghese Co: Post Box 119-Bombay-31, Publication; 1986.pp.183–84
2. Jhon Y Basmajjan. Grant Method of Anatomy, 8th edition. William and Wilkins Co: Baltimore USA; 1972.pp.566–67.
3. Hutchinson A C W. In: Palatal and Oral X-ray Diagnosis, 1st edition. Edinberg: Living stone; 1954.pp.29–31.
4. Shankland W. The position of mental foramen in Asin. The Journal of Oral Implantology. 1994 Jan;20(2):118-123
5. Singh R, Srivatsav A K. Study of position, shape size and incidence of mental foramen and an accessory mental foramen in Indian Adult Human Skulls. Int J Morphol. 2010:28:1146–48.
6. Al Khateeb T, Al Hadi Hamsha A and Ababneh KT. Position of the mental foramen in the Northern Region of Jordian population. Radiol Ant. 2007;29: 231–37.
7. Budhiraj Veerendra, Rastogi Rakhi, Lawani Rekha. Study of position shape and size of mental foramen utilizing various parameters in Dry Adult Human Mandible from North India: Hundavi Publishing Corporation ISBN Anatomy; Vol 2: Article ID 961429,2013, http// dx. Dot.org/1054 27 2013/961429 viewed on 2019 January 16.
8. Marshall Joseph Becker. Mandibular symphysis (medial suture) closure in modern Homo sapiens: Preliminary evidence from archaeological populations. Am J Phys Anthoropol. 1986;69:499–502.
9. Ernest Frazer J. The Anatomy of Human Skeleton. 3rd edition. J and A Churchill 40: Gloucester place London; 1933.pp.270–71.
10. Hooton EA. Up from Ape 2nd edition (revised). Mac Millon Co: New York; 1963.pp.88–9.

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Morphometric Study of Femoral Neck-Shaft Angle in Kolar Population and Its Clinical Importance

Suresh NM[1], Sunitha R[2], Aruna N[3], Nalini JP[4]

Abstract

Background: The Neck Shaft Angle axis of the shaft and axis of neck of femur.the angle is also named as caput collum diaphysis or cervico diaphyseal angle. Anthropometric skeletal measurements are used to show regional diversity between different populations or even within the same population. Moreover, skeletal measurements and shape of the bones can offer a guide to clinicians for determining the risk factors for fractures. *Aim:* The present study was undertaken to analyse femur neck shaft angle in kolar population. The standard commercially available marked prosthesis sometimes may not be the best fit to the Indian patients because of wide anatomic variation which leads to complications due to mismatch like aseptic loosening, improper load distribution and discomfort. *Set up:* Department of anatomy, Sambhram Institute of Medical Science and Research**.** *Study Design:* The present study is a cross-sectional observational study. *Materials and Methods:* The materials for the present study comprised of 100 (50 right side and 50 left side adult dry femora. Neck shaft angle was measured with help of goniometer in degrees. Mean and standard deviation were calculated. The student *t*-test was applied and side wise comparison was done by a two-tailed student *t*-test. A level of significance of 5 percent ($p < 0.05$) was used for all analysis. *Results:* No significant side difference is noted in Neck Shaft Angle in degree on comparing both sides. Range of Neck Shaft angle on right side is 120–138° Range of Neck Shaft angle on left side is *122–137°*, *p*-value 0.21–not significant. Mean neck shaft angle of both the sides is *128.51° Conclusion:* The values obtained were greater in western world than in present study, there is regional variation among different regions of India. This study will encourage the biomechanical engineers to design and manufacture implants with a correct morphometric data to suit our Indian population and for an improvised surgical outcome with prevention of complication.

Keywords: Kolar; femur; neck shaft angle; implants.

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Introduction

The femur is largest and strongest bone in human body. It consists of proximal end, shaft and distal end. The proximal end of femur has much attention. The knowledge of its anatomy is important in the treatment of pathology conditions of hip and femur. The Neck-Shaft angle axis of the shaft and axis of neck of femur the angle is also named as Caput Collum Diaphysis or Cervico Diaphyseal angle (CCD).[1]

The neck axis is the line drawn from centre of femoral head to centre of femoral neck at the narrowest part of the neck. The shaft axis is the line drawn from the middle of femoral condyles to middle of the greater tronchanter, this corresponds to "Ideal Axis'' by Billing and long axis by Norman.[2,3]

There are metric differences in skeletal components among different population and these

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variations are related to genetic and environmental factors also. Variations seen in human skeletal measurements also determine the racial characteristics of the populations.[4,5]

Anthropometric skeletal measurements are used to show regional diversity between different populations or even within the same population. Moreover, skeletal measurements and shape of the bones can offer a guide to clinicians for determining the risk factors for fractures. Femoral neck shaft angle has been related as one of the factor for mechanical strength of upper end of femur. Increased neck shaft angle associated with increased risk of fracture. There is difference of the anthropometry of upper end of femur between ethnics due to differences in lifestyle, physique, applied force and their distribution.

Another problem is implant-morphology mismatch that might cause difficulties during implant replacement and could lead to accelerated deterioration of implant life and thus affecting short-term and long term outcome of surgery. The Neck Shaft angle varies from within *125° to 132°*. Undersized or overhanging femoral implants could result in altered soft tissue tensioning and altered patella femoral stresses.

A smaller Neck Shaft angle means that a Dynamic Hip Screw (DHS) inserted through the classical entry portal using angled guide will either go into the superior quadrant or pull fracture in valgus both of which are harmful. The incidence of intraoperative complications like splintering and fractures ranges from 4 to 21%. These are due to oversized implants available that have been manufactured basically with western parameters.[6]

The present study was undertaken to analyse femur neck shaft angle in kolar population. The standard commercially available marked prosthesis sometimes may not be the best fit to the Indian patients because of wide anatomic variation which leads to complications due to mismatch like aseptic loosening, improper load distribution and discomfort. There is no study regarding femoral Neck Shaft angle in Kolar population, so this data will be useful in the designing of appropriate implants to suit femora of Kolar population giving information to Biomedical engineers an Orthopaedicians alike in the development of implants and practice related to hip joint.

Materials and Methods

The materials for the present study comprised of 100 (50 right side and 50 left side adult dry femora from Department of Anatomy and Department of Forensic Medicine, Sambhram Institute of Medical Science and Research**.**

Inclusion Criteria

Adult human dry femur bones of both sexes 50 right side and 50 left side.

Exclusion Criteria

Bones with visible osseous pathologies like tumors; deformities; fracture; trauma.

Instruments

Goniometer, Scale

Parameters

Neck Shaft Angle

It was measured on the anterior surface of the femur as the Obtuse angle between the long axis of neck and long axis of proximal part of the shaft of the femur. Neck axis is drawn in the center of the neck of the femur by joining two points equidistant from the superior and inferior surface of the femoral neck and parallel to it.

The femoral shaft axis is defined by the line drawn through the centre of the medullary canal along the axis of the femur. It is measured with help of goniometer in degrees[7] (**Fig. 1**).

The present study is a cross-sectional observational study. Parameter-Neck Shaft angle of femur belonging to both right and left sides were tabulated; mean and standard deviation were calculated. The student *t*-test was applied and side wise comparision was done by a two-tailed student *t*-test. A level of significance of 5 percent ($p < 0.05$) was used for all analysis.

Results

No significant side difference is noted in Neck Shaft angle in degree on comparing both sides (**Table 1**).

Range of Neck Shaft angle on right side is *120–138°*.

Range of Neck Shaft angle on left side is *122–137°*.

p-value 0.21-Not significant.

Mean Neck Shaft angle of both the sides is *128.51°*.

Fig. 1: Measurement of Femur Neck Shaft Angle using Goniometer

Table 1: Comparison of Mean and SD of Neck Shaft Angle (NSA)

Side	Sample Size	Mean	SD	*p*-Value	Inference
Right	50	129.04	4.47	> 0.05	Not significant
Left	50	127.98	4.01		

Discussion

Comparison of neck shaft angle in various studies in **Table 2.**

The Neck-shaft angle also shows gender difference, smaller in females due to wide pelvis. There is a racial difference owing to the morphology of head, neck and shaft of femur. Normal range of Neck-shaft angle varies from *120° to145°* with an average value of *135°* [20]Anatomical study of femur bone serves helpful data to understand different aspect of clinical disease conditions, including common site of fracture, changes in osteoporosis, associated congenital anomalies as well as medicolegal cases.

Table 2: Showing comparison of Neck Shaft Angle in various studies

Author	Ethnic Group	Mean Value in Degrees
Horacio Osario[8]	Chile	124.17
Rubin *et al.*[9]	Swiss	122.9
Husmann *et al.*[10]	France	129.2
Isaac B *et al.*[11]	Thai	126.9
Toogood Paul[12]	White and American	126.7
Noble *et al.*[13]	caucosids	125.4
Aparna *et al.*[14]	Andra Pradesh, India	121
Amit R *et al.*[15]	India	121.2
Christoph Kolija Boese *et al.*[16]	Germany	163
Radha Pujari *et al.* [17]	Raichur, India	127.5
PF Umebese 2005[18]	Nigeria	121
Vipin Sharma *et al.*[19]	Subhimalaya, India	126.9
Present study	Kolar, India	128.51

Table 3: Showing comparison of Neck Shaft Angle with commonly used implants[6]

Implant	Value in Degrees
Dynamic hip screw (DHS)	125–155
Commonly used DHS	135
Condylar blade plate	95–130
Commonly used condylar blade plate	95–110
Present study	128.5

Its shaft is almost cylindrical. It has a proximal rounded articular head projecting medially from its short neck. The femoral neck length is approximately 5*cm* long and connects the head to shaft at an average angle of *135*°. This angle facilitates movements at the hip joint, enabling the limb to swing clear of the pelvis.[21] Osteoporosis is generally considered to be a condition affecting women, but up to 30% of fragility fractures occur in men.[21] Many methods are available for measuring the femoral Neck-shaft angle which include fluoroscopy, radiography, computed tomography (CT), and Magnetic Reasoning Imaging (MRI). Due to the wide variation in health infrastructure in our country, it may not always be possible to measure the femoral Neck-shaft angle by CT and MRI. Mean NSA right side 127.02 left side125.71.[19]

The mean Neck-shaft angle of study by Shivashankarappa *et al.* was *138.3 + 5.67*°, the right femur Neck-shaft angle *138.3 + 5.67*° and the left was *138.3 + 5.67*°.[20] Ravichandran *et al.* study, in their study the Neck-shaft angle was *126.55*°,[6] Study of Subhash Gujar, the average Neck-shaft angle was *136.2*°.[21] In Siwach RC study it was *123.50*°.[22] The mean Neck-shaft angle of Shakil *et al.* study *137.1*°, the right Femur Neck-shaft angle *137.3*° and the left was *136.9*°. [23]

In the study by Smirti the mean Neck-shaft angle in the femora was *131.48 ± 5.005*° in the right femora *131.44 ± 4.72*°and in the left femora *131.53 ± 5.29*°. The mean Neck-shaft angle of the left femora was feebly higher than the right side, which was satistically non-significant ($p > 0.05$).[24] This was very similar to the earlier South Indian study by Singh (1986) who found mean neck shaft angle for the left femora *131.3±3.9*° and for the right femora 131.0 ± 3.6°.[25] Similarly Subhash Gujar (2013) also found 136.6 ± 5.45° for left femora and 136 ± 6.68° for the right femora.[21] In another study by Issac (1997) in South Indian population the mean Neck-shaft angle found on the left side 126.5° and on the right side 126.9°.[11] The Shakil Mohammad (2014) found mean neck shaft angle of right femora was 137.44° and of left femora was 136.9°. [23]

When angle is < 120°, it is known as coxa vara. The angle of femoral neck is reduced with age. In early infancy the Neck-shaft angle is about 150°, in childhood 140°, in adult about 125° and in elderly about 120°.[5] The clinical importance of neck shaft angle of femur lies in the diagnosis, treatment and follow up of fractures of the neck of femur, trochanteric fractures, slipped upper femoral epiphysis, development dysplasia of the hip and neuromuscular disorders of the lower extremity. The knowledge of normal asymmetry of right and left Neck-shaft angle of femur may be of great value in evaluation of patient with known or assumed pathological conditions and in correctional osteotomies in case of femoral fractures.[11]

Conclusion

The Neck-shaft angle of femur allows greater mobility of the femur at the hip joint. All the clinician must be familiar with normal Neck-shaft angle for better comprehension of clinical and pathological states of hip joint. The Neck-shaft angle, is important to design prosthesis for hip replacement. Considering the above mentioned importance the present study was conducted to assess the Neck-shaft angle of femur, its variation with respect to side.

In the present study the mean Neck-shaft angle in the femora was *128.51°*, in the right femora 129.04° and in the left femora 127.98°. The mean Neck-shaft angle of the right femora was feebly higher than in the left femora but statistically not significant ($p > 0.05$). So there is no significant difference between mean neck shaft angle of right and left femora. Femor Neck-shaft angle was measured in all femur and statistical analysis of each parameter by side wise comparison was made. The values obtained were compared with those reported in the literature. And the values were compared with dimensions of commonly used implants in the field of orthopaedics.The values obtained were greater in Western World than in present study showing regional variation among different regions of India. This study will encourage the biomechanical engineers to design and manufacture implants with a correct morphometric data to suit our Indian population and for an improvised surgical outcome with prevention of complication.

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References

1. Reikeras O, Hoiseth A. Reigstad A, *et al.* Femoral neck angles. Acta orthop. Scand. 1982;53:775–79.
2. Billing, L. Roentgen examination of the proximal femur-end in children and adolescents. Actu Radiol. 1954;Suppl.110.
3. Norman, O. Matning av collumante-versionsvinkeln. En principiell diskusjon. Nord Med. 1969;75:318.
4. Igibigi. Sex determination from femoral head diameters in black Malawians. East African Medical Journal. 2000;77(3):147–51.
5. Gray's Anatomy. Susan Standring, 40th edition. Churchill Livingstone; pp.1360–390.
6. Ravichandran D, Muthukumaravel N, Jaikumar R. Proximal femoral geometry in Indians and its clinical applications. J Anat Soc India. 2011;60(1):6–12.
7. Olav R, Arne H, Astor R, *et al*. Femoral Neck-angles: A specimen study with special regard to bilateral differences. Acta Orthop Scand. 1982;53:775–79.
8. Horacio O, Karl S. Proximal femoral ephiphysis anatomy in Chilean Population. Orthopaedic and Forensic Aspects. Int Jour of Morphology. 2012;30(1):258–62.
9. Rubin PJ, Leyvraz PF, Aubaniac JM. The morphology of the proximal femur. A three-dimensional radiographic analysis. Bone Joint Surg Br. 1992;74:28–32.
10. Husmann O, Rubin PJ, Leyvraz PF, *et al*. Three-dimensional morphology of the proximal femur. J Arthroplasty. 1997;12:444–50.
11. Issac V, Prasad J, *et al*. Prediction of the Femoral Neck-shaft angle from the length of the femoral neck. Clin Anat. 1997;10:318–23.
12. Toogood PA, Skalak A. Cooperman proximal femoral anatomy in the North-eastern Region population. Clin Orthop Relat Res. 2009;467:876–85.
13. Noble PC, Alexander JW, Lindahl LJ, *et al*. The anatomic basis of femoral component design. CORR.1988;148–65.
14. Gullapelli A, Inuganti AK. Morphometric study of Femoral Neck-shaft angle and its clinical significance. Int J Anat Res. 2017;5(3.2):4261–64.
15. Amith R. Morphometry of femoral NSA in dry femora of South India by computer assisted image analysis method, Int J Anat Res. 2017;5(2.1):3753–58.
16. Kolja BC. The modified Femoral Neck-shaft angle: Age and sex- dependent reference values and reliability analysis. Journal of Biomedical Research International. 2016; Article ID 86475627:7
17. Pujari R, Shankar G Ravi. Evaluation of Neck-shaft angle of femur or dry bones. Journal of evaluation of medicals dental sciences. 2015;4(32):5518–522.
18. Umebese PF, Adeyekun A, Moin M. Radiological assessment of Femoral Neck-shaft and anteversion angles in adult Nigerian HIPS. Niger Postgrad Med J. 2005 Jun;12(2): 106–9.

19. Sharma V, Kumar K, Kalia V, *et al.* Evaluation of Femoral Neck-shaft angle in Sub-Himalayan population of North-west India using Digital Radiography and Dry Bone Measurements. Journal of the Scientific Society. 2018 January-April;45(1).
20. Shivashankarappa A, Prasad NC and Havaldar PP. A study on Femur Neck-shaft angle and its clinical importance. IJOS. 2017;3(4):755–57.
21. Gujar S, Vikani S, Parmar J, *et al.* A correlation between Femoral Neck-shaft angle to Femoral Neck-length. IJBAR. 2013;04(05).
22. Siwach RC, Dahiya S. Anthropometric study of proximal femur geometry and its clinical application. Indian journal of Orthopaedics. 2003;37(4):247–51.
23. Mohamad KS, Hussain SS. Study on Neck-shaft angle and Femoral length of South Indian Femurs. Int J Anat Res. 2014;2(4):633–35.
24. Jha S, Prasad R, Dubey AK. Study of right and left Asymmetry in Neck- shaft angle and neck length of Femur in Jharkhand Population. IOSR-JDMS; 2016 September;15(9 Ver IV):19–21.
25. IP Singh, GJ Ekandem, EO Ani. Identification of sex from the head of the femur- demarking points for Calabar, Cross-River State Nigeria. West Afr J Anat. 1986;1:16–23.

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Morphological Study of Anterior Coracoscapular Ligament

Dandekar Usha K[1], Dandekar KN[2]

Abstract

Suprascapular notch harboring the two ligaments, namely superior transverse scapular ligament and anterior coracoscapular ligament is a potential site contributing in causation of suprascapular nerve entrapment syndrome. The etiological role of superior transverse scapular ligament in suprascapular nerve entrapment syndrome is established and it needs to be excised in the treatment of suprascapular nerve entrapment syndrome. The anterior coracoscapular ligament is recently introduced as a new risk factor. The mystery about the role of this ligament in suprascapular nerve entrapment syndrome attracted us to undertake morphological study of this ligament. In this study, anterior coracoscapular ligament was found as a separate fibrous band in 41.2%. According to the distal attachment of the ligament as suggested by Piyawinijwong, we found three types of anterior coracoscapular ligament: type I (52.4%), type II (40.5%) and type III (7.1%). According to the shape of ligament, we found anterior coracoscapular ligament as– Fan shaped (47.6%), band shaped (42.9%), bifid (2.4%) and vestigial type (7.1%). The mean cross sectional area of suprascapular opening with anterior coracoscapular ligament was estimated as 29.86 mm^2 and without anterior coracoscapular ligament it was 29.35 mm^2. The mean middle width of suprascapular opening with anterior coracoscapular ligament was 3.8 mm and without anterior coracoscapular ligament it was 4 *mm*. The suprascapular nerve as the only structure passing through suprascapular opening was seen in 50%. The suprascapular nerve along with suprascapular vein passing through suprascapular opening was seen in 20.6% whereas suprascapular nerve and suprascapular vessels passed through suprascapular opening in 17.6%. Accessory suprascapular veins were found in 11.8%. The anterior coracoscapular ligament apparently contributes to reduce the area of suprascapular opening leading to compression of suprascapular nerve which may cause suprascapular nerve entrapment syndrome. The anterior coracoscapular ligament if present is one of the equally important predisposing factors as superior transverse scapular ligament. Variations in morphology of anterior coracoscapular ligament may influence the area of suprascapular opening through which suprascapular nerve passes. Therefore one should not underestimate the importance of anterior coracoscapular ligament.

Keywords: Anterior coracoscapular ligament; Suprascapular nerve entrapment syndrome.

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Introduction

The Suprascapular Notch (SSN) is a potential site contributing in causation of Suprascapular Nerve Entrapment Syndrome (SNES). The reduction in space in SSN through which the suprascapular nerve passes may lead to its compression causing SNES whose symptoms include nagging pain over the posterolateral region of shoulder and severe cases may show atrophy of the supraspinatus and infraspinatus muscles along with weakness of abduction and external rotation of upper limb.[1-3]

The SSN harbors two ligaments: Superior Transverse Scapular Ligament (STSL) and Anterior Coracoscapular Ligament (ACSL). The STSL is a constant ligament while ACSL is infrequent. Both are incriminated as predisposing factors in causation of SNES by various authorities. André

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Thomas (1936) was the first to describe mechanisms leading to the development of SNES[4]. In 1959 Kopell and Thompson stated that abduction or horizontal adduction of the shoulder exert traction on the suprascapular nerve causing its compression.[5] Rengachary[6] suggested a "sling effect" by STSL causing traumatic kinking of the suprascapular nerve. These reports established STSL as a predisposing factor contributing injury and compression of suprascapular nerve causing SNES. In 2002, Avery *et al.*[7] introduced another independent ligament, "ACSL", as a new risk factor. ACSL is a fibrous band extending anterior to the suprascapular notch and inferior to STSL. Thus the suprascapular nerve passes through the foramen bounded superiorly by the inferior border of STSL, inferiorly by superior border of ACSL if present or inferior border of SSN in absence of ACSL and bony margins of SSN on each side[8]. The incidence of ACSL varies from 18.8% to 60% of population.[7-14]

Since the introduction of ACSL, its role in causation of SNES has remained controversial. Some authors held it (ACSL) as predisposing factor in SNES while some considered it to provide protective cushioning effect. The mystery about the role of this ligament in SNES and lack of description in standard textbook attracted us to undertake morphological study of ACSL.

Materials and Methods

The study was carried out on 102 embalmed adult human shoulders in the Department of Anatomy, Rural Medical College, Loni. Institutional Ethical clearance was obtained from the IEC of Pravara Institute of Medical Sciences Deemed University to which the Rural Medical College is affiliated. [Letter PIMS/IEC-DR/2018/288dated 11/12/2018 Reg.No: PIMS/DR/ RMC/2018/273].

Exclusion criteria consisted of presence of any operative interventional procedure in suprascapular region and congenital anomalies of shoulder. Dissection of the suprascapular region was carefully performed by incising and reflecting the skin and soft tissues layer wise. The scapular muscles were demonstrated and then reflected to expose the superior border of scapula and SSN. The STSL, ACSL and suprascapular nerve and vessels were identified and skeletonized. The morphometry of ACSL, the relationship of the suprascapular nerve and vessels to ACSL and presence of any abnormal mass in this area were carefully recorded. The Cross sectional area of suprascapular opening was calculated by using the formula for an ellipse: Area = $\pi \times D1/2 \times D2/2$ where D1 is vertical diameter of suprascapular foramen and D2 is transverse diameter of the suprascapular foramen.[15] Digital Vernier caliper was used to record measurements and multiple photographs obtained. Data obtained in the present study was compared with that of available literature in different populations.

Results

ACSL was found as a fibrous band in 42 shoulders (41.2%). The ligament was situated below the STSL and attached laterally to the root of coracoid process and extended to anterior surface of the scapula or to the inferior margin of SSN. According to the distal attachment of the ligament, as suggested by Piyawinijwong classification [11], we found three types of ACSL as type I (52.4%) (**Fig. 1**),

Fig. 1. Type I: ACSL extending to anterior surface of scapula further away from SSN

Fig.2. Type II: ACSL sub-dividing the SSN into two foramen

type II (40.5%) (**Fig. 2**) and type III (7.1%) (**Fig. 3**). According to the shape, ACSL was found as–Fan shaped (47.6%) (**Fig. 4**), band shaped (42.9%) (**Fig. 5**), bifid ACSL (2.4) (**Fig. 6**) and vestigial type (7.1%).

In the present study, the mean cross sectional area of suprascapular opening with ACSL was estimated as 29.86 mm^2 and without ACSL it was 29.35 mm^2.The mean middle width of suprascapular opening with ACSL was estimated as 3.8 *mm* and without ACSL it was 4 *mm*. we also demonstrated the mean cross sectional area and mean middle width of suprascapular opening in different types of STSL with and without ACSL.

In our study, the suprascapular nerve as the only structure passing through suprascapular opening was seen in 50%. The suprascapular nerve along with suprascapular vein passing through suprascapular opening was seen in 20.6% whereas suprascapular nerve and suprascapular vessels passed through suprascapular opening in 17.6%.

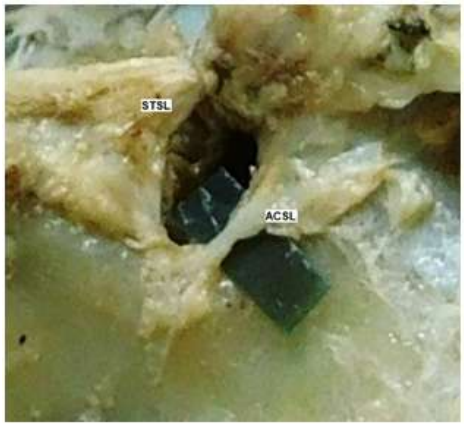

Fig. 3. Type III: ACSL extending up to inferior border of SSN

Fig. 4. Band shaped ACSL

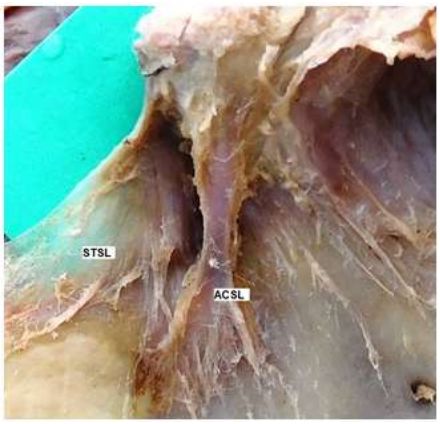

Fig. 5. Fan shaped ACSL

Fig. 6. Bifid ACSL

Accessory suprascapular veins were found in 11.8%.

Discussion

ACSL is one of the important factors in the causation of SNES as it may reduce the area of suprascapular opening leading to compression of suprascapular nerve. However, Polguj[1] in 2013 postulated that the presence of ACSL may prevent the development of suprascapular neuropathy, unless it does not significantly reduce the space under the STSL. In that case, the ligament supports the nerve to prevent its excessive movement and forms a canal which enables direct passage of the nerve from the front side of the scapula to the supraspinous fossa. Thus, by supporting the nerve, ACSL can protect against its injury. Podgorski[8] postulated

that mechanically efficient ACSL is more common in the deep and narrow type of suprascapular notch which is more prone to SNES.

In our study the incidence of the ACSL was 41.2%. It was higher than that seen by Piyawinijwong[11]. Bayramoglu[13], and Gurses[14] but was lower than that described by Avery[7]. Polguj[9] Polguj[10], Polguj[12], Podgorski[16], Polguj[17]. Polguj[12] in 2012 classified the ACSL into 4 types based on specific geometrical parameters and morphology. In type I the ligament is uniformly fan shaped. In this type the ratio of Maximal Proximal Width (MPW) to Maximal Distal Width (MDW) is equal or more than two. The type II is band shaped. The ratio between MPW and MDW is less than two. The type III is bifid in which two independent bands are present at the medial edge of the SSN. Type IV is vestigial where the ligament is presented as a small band running in the area of the inferior border of the SSN. Gurses[14]

Table 1: Comparison of types of ACSL according to shape

Shape of ACSL	Michal Polguj[12]	Gurses[14]	Present study
Fan shaped	7	25	47.6
Band shaped	62.8	68.7	42.9
Bifid	11.6	0	2.4
Vestigial	18.6	6.3	7.1

found above mentioned three types. They did not get bifid ACSL (Type III). In our study, we found all four types but the findings are not corresponding with Polguj[12] and Gurses[14] study (**Table 1**).

According to distal attachment of the ACSL, Piyawinijwong[11] distinguished three types as follows: In Type I (15.79%), the distal attachment extended to the anterior surface of the scapula further away from inferior border of the SSN. In Type II (63.16%) the distal attachment extended across the SSN and subdivided the notch into two foramina. In Type III (21.05%), the distal attachment extended near the bottom of the SSN. Type II and III were the most vulnerable types as they reduced the space for the passage of suprascapular nerve through suprascapular opening[11]. We found these types in 52.4%, 40.5% and 7.1% respectively which are not corresponding to the study done by Piyawinijwong.[11] Polguj[12] found difficulty to compare their method of classification of ACSL to Piyawinijwong's classification. They considered vestigial ACSL as type III and other shaped ACSL together as type I and II.

The mean cross sectional area of suprascapular opening with ACSL was estimated as 29.86 mm^2 and without ACSL it was 29.35 mm^2. Polguj[12] reported these findings as 29 ±18.4 mm^2 and 33.06 ±18.93 mm^2. Polguj[10] emphasized the alteration in mean area and mean middle width of suprascapular opening in different types of STSL with ACSL as well as without ACSL. They reported mean area and mean middle width of suprascapular opening in cases of band shaped STSL with ACSL were lower than without ACSL. In cases of fan shaped STSL they found similar values in specimens with ACSL and without ACSL. Bifid STSL had similar findings as band shaped STSL. Our findings are corresponding with Polguj[10] study in case of band shaped STSL but not with fan shaped and bifid STSL.

The relationship of ACSL to suprascapular nerve and vessels has clinical importance with regards to entrapment of suprascapular nerve. In the present study, in all cases the suprascapular nerve passed through suprascapular opening formed by STSL and ACSL in specimens having ACSL or STSL and inferior border of SSN in specimens without ACSL. Podgorski[8] found the same findings. In Polguj[12] study the suprascapular nerve passed inferior to ACSL in 2 specimens and superior to it in 41 specimens. Polguj[9] reported the suprascapular nerve passing superior to ACSL through the suprascapular foramen in 91 cases and inferior to the ACSL in two specimens. Polguj[17] found 2.8% cases in which suprascapular nerve passed under the ACSL and in 49.1% cases it passed above the ligament.

The chances of SNES increase if structures passing through suprascapular opening are more in number. The structures that surround the suprascapular nerve can cause its compression and damage[18]. Podgorski[19] mentioned that the SSN vein and ACSL may support a cushion mechanism for the suprascapular nerve protecting it against repeated microtrauma. Standard textbooks mentioned that the suprascapular nerve passed below STSL through suprascapular opening and the suprascapular vessels passed above the STSL[20]. The relation of suprascapular vessels and suprascapular nerve was described by Polguj[10,17]. Polguj[10] classified these relations into 2 types as: First Type-the suprascapular artery ran above the STSL and the suprascapular vein and nerve ran below it. Second type-the suprascapular vessels

were above the STSL and the suprascapular nerve was below it. Polguj[17] further classified these relations into 4 types. First 2 types are same as above. In type III the suprascapular vessels and nerve passed through suprascapular opening. Type IV comprised the other variants of these structures as the occurrence of the accessory suprascapular veins and the cases in which the analyzed structures pass under the ACSL. Gurses[14] proposed another threefold classification of relations of suprascapular structures to ACSL. Type I is typified by single suprascapular nerve passing between the STSL and ACSL (18%). Type II is subdivided into IIa and IIb: Type IIa possessing single suprascapular vein with suprascapular nerve passing between the STSL and ACSL (12%) and Type IIb possessing single suprascapular vein passing under the ACSL and suprascapular nerve passing between the STSL and ACSL (2%). In Type III, the whole suprascapular triad (suprascapular artery, vein, and nerve) passes between the STSL and ACSL (4%). In my previous study on STSL[21] I have reported first 3 types whereas Podgorski[16] reported first and third types. In the present study we found all 4 types but the findings are not corresponding to other's study (**Table 2**).

Double suprascapular foramen have been demonstrated by Serghei[18] and Polguj[22] probably caused by ossification of both STSL and ACSL. Saritha[23] found co-existence of SSN and suprascapular foramen. These reports indicate that the presence of two bony bridges may be a factor in the increased risk of occurrence of suprascapular neuropathy.

Table 2: Comparison showing relations of neurovascular structures to ACSL and STSL according to Polguj classification.[17]

	Polguj[10] %	Podgorski[16] %	Polguj[17] %	Gurses[14] %	Usha [21] %	Present study %
Type I	72.1	96	61.3	12	29.03	20.6
Type II	27.9	0	17	18	54.84	50
Type III	-	4	12.3	4	16.13	17.6
Type IV	-	-	9.4	2	-	11.8

Conclusion

It has been suggested that reduction in the space available for the passage of suprascapular nerve may predispose its compression and injury leading to the SNES. The ACSL if present is one of the equally important predisposing factors as STSL. Variations in morphology of ACSL may influence the area of suprascapular opening through which suprascapular nerve passes. Therefore, one should not underestimate the importance of ACSL.

Conflict of Interest: Nil

References

1. Polguj M, Synder M, Borowski A, *et al.* "Anterior coracoscapular ligament as a factor predisposing to or protective for suprascapular neuropathy." Bio Med Research International. 2016;6
2. Zehetgruber H, Noske H, Lang T, *et al.* Suprascapular nerve entrapment, A meta-analysis International Orthopedics (SICOT). 2002;26:339–43.
3. Aly El Sayed, Metwally M, Elshenety RM, *et al.* Suprascapular nerve: Anatomical and Clinical Study. International Journal of Clinical and Experimental Medical Sciences. 2016;2(3):31–39.
4. Pecina M. Who really first described and explained the suprascapular nerve entrapment syndrome. J Bone Joint Surg Am. 2001;83-A(8):1273–7.
5. Thompson WAL, Kopell HP. Peripheral entrapment neuropathies of the upper extremity. New Engl J Med. 1959;260:1261–65.
6. Rengachary SS, Burr D, Lucas S, *et al.* Suprascapular entrapment neuropathy: A clinical, anatomical, and comparative study. II: Anatomical study, Neurosurg. 1979;5(4): 447–51.
7. Avery BW, Pilon FM, and Barclay JK. Anterior coracoscapular ligament and suprascapular nerve entrapment. Clinical Anatomy. 2002;15(6):383–86.
8. Podgorski M, Topol M, Sibiński M, *et al.* What is the function of the anterior coracoscapular ligament?–A morphological study on the newest potential risk factor for suprascapular nerve entrapment. Annals of Anatomy. 2015;201:38–42,
9. Polguj M, Jędrzejewski K, Majos A, *et al.* Variations in bifid superior transverse scapular ligament as a possible factor of suprascapular

entrapment: An Anatomical Study. Int Orthop. 2012;36:2095–100.

10. Polguj M, Jedrezwski K, Podgorski M, *et al.* A proposal for classification of the superior transverse scapular ligament: Variable morphology and its potential influence on suprascapular nerve entrapment. J Shoulder Elbow Surg. 2013; 22:1265–73.
11. Piyawinijwong and S, Tantipoon P. The anterior coracoscapular ligament in Thais: Possible etiological factor of suprascapular nerve entrapment. Siriraj Medical Journal. 2012;64:S12–S14.
12. Polguj M, Jędrzejewski K, and Topol M. Variable morphology of the anterior coracoscapular ligament: A proposal of classification. Annals of Anatomy. 951;8(1): 77–81.
13. Bayramoglu A, Demiryurek D, Tuccaretal E. Variations in anatomy at the suprascapular notch possibly causing suprascapular nerve entrapment: An Anatomical Study. Knee Surgery, Sports Traumatology, Arthroscopy. 2003;11(6):393–98.
14. Gurses IA, Gayretli O, Coskun O, *et al.* Anatomical relations between anterior coracoscapular ligament and suprascapular neurovascular structures and a proposal for classification. Acta Orthopaedica et Traumatologica Turcica. 2015;49(4):433–37.
15. Mitchell J. The incidence and dimensions of the retroarticular canal of the atlas vertebra. Acta Anatomica. 1988a;163:113–20.
16. Podgórski M, Topol M, Sibiński M, *et al.* New parameters describing Morphological variations in the suprascapular notch region as potential predictors of suprascapular nerve entrapment. BMC Musculoskeletal Disord. 2014;15:396.
17. Polguj M, Roznіecki J, Sibiński M, *et al.* The variable morphology of suprascapular nerve and vessels at suprascapular notch: A proposal for classification and its potential clinical implications. Knee Surgery, Sports Traumatology, Arthroscopy. 2015;23(5):1542–548.
18. Covantev S, Belic O, Mazuruc N. Double suprascapular foramen: A rare scapular notch variation. Russian Open Medical Journal. 2016;5(3):1–3.
19. Podgórski M, Sibinski M, A. Majos, *et al.* The suprascapular vein: A possible etiology for suprascapular nerve entrapment and risk of complication during procedures around the suprascapular foramen region. Orthopaedics and traumatology, surgery and research: OTSR. 2014;100(5):515–19.
20. Grays Standring S. Gray's Anatomy: The Anatomical Basis of Clinical Practice, 40th edition. New York, USA: Churchill Livingstone Elsevier; 2008.
21. Dandekar U, Dandekar K. Cadaveric morphological study of superior transverse scapular ligament and its clinical correlation. Indian J Clin Anat Physiol. 2019;6(2).
22. Michał P, Michał P, Kazimierz J, Miroslav T, The double suprascapular foramen: Unique anatomical variation and the new hypothesis of its formation. Skeletal Radiol. 2012;41:1631–636.
23. Saritha S. Co-existence of suprascapular notch and suprascapular foramen. A rare anatomical variation and its clinical correlation: A Case Report. International journal of medical science and clinical Invention. 2014;1(2):65–8.

Original Article

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Correlation between Gestational Age and Head Circumference in Second Trimester

Varsha Pande[1], Vaishali Inamdar[2], Swapnil Patond[3]

Abstract

Introduction: In today's advanced medical world maternal child health care the important part of the healthcare system and important components is estimation fetal gestational age. Gestational age is age of unborn baby, defined in weeks as beginning from first day of last menstrual period prior to conception. Trimester is period of three calendar months during a pregnancy. Radiologically the period of gestation is grossly divided into three trimesters. Estimation of gestational age and thereby forecasting Expected Date of Delivery (EDD) is not only concern of the Individual but it is invaluable in the diagnosis of intrauterine growth retardation of fetus and obstetric planning. Hence we proposed the present study to evaluate fetal Head Circumference for measuring the gestational age. *Materials and Methods:* The study Correlation between gestational age and head circumference in second trimester was carried out at Govt. Medical College and Hospital, Nanded, between July 2011 to July 2013 period. The study included 150 pregnant women the data so collected was then subjected to statistical analysis by expert statistician with the help of SYSTAT Crainsoft version 12 software. Standard statistical methods, parametric methods were used for the evaluation and significance. *Results:* Variation in fetal growth on the basis of Head Circumference during second trimester can be explained to the extent of 96.65%. The value of *R* is highly significant (Student's '*t*' test value = 149.10, $p < 0.0001$, highly significant) showing that there is statistically positive correlation between gestational age and Head Circumference. *Conclusion:* From the present study it is found that Head Circumference and gestational age are statistically highly significant. The regression equations derived for growth parameter for estimating gestational age in a normally developing fetus, increase with gestational age, showed good correlation with gestational age. In Present study, Head circumference is the sensitive parameter and results of present study were comparable with previous studies.

Keywords: Age; Fetal; Gestational age.

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Introduction

Beginning of human development start as oocyte from female which is fertilized by the sperm. Cell division, differentiation, growth transfigure the fertilized oocyte into a multicellular adult human being. Most of the changes occur during the early fetal and embryonic period, the development of which divided into pre and postnatal period. There are many changes that occur from the 3rd to 8th week called as embryonic development and changes occur from 9th week to birth into a recognizable human being called a fetus.[1]

Gestational age is age of unborn baby, defined in weeks as beginning from first day of last menstrual period prior to conception. Trimester is period of three calendar months during a pregnancy. Radiologically the period of gestation is grossly divided into three trimesters. Estimation of gestational age and thereby forecasting Expected Date of Delivery (EDD) is not only concern of the Individual but it is invaluable in

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the diagnosis of intrauterine growth retardation of fetus and obstetric planning.

The parameters either singly or in combination useful in predicting the gestational age with fair degree of accuracy are Naegeles formula, Date of quickening, Palpation of fetal parts and Auscultation of fetal heart sound.[2]

The methods like physical examination, menstrual history, and laboratory methods have limitations in assessing fetal maturity, development and well being. At the same time Roentgenography like procedures having hazards of invasive procedure or radiation compelled the research of safer, non-invasive and reliably predictive investigation modality, it was brought forth in the form of Ultrasonography. Added advantage of it being evaluation of multiple parameters in the same readings. Ultrasonography is non-ionising, non-invasive, safe and accurate method of objectively evaluating the fetal growth in uterus.

In any obstetrics case correct assessment of gestational age is keystone. Measurements and fetal characteristics are helpful in estimating fetal age. To determine the fetal age at the end of 1st trimester the crown rump length is method of choice because of negligible variation in the size of fetus during the period.

In second and third trimester, fetus grows sufficiently in size; several structures can be identified and measured ultrasonographically.

Accurate knowledge of gestational age is a keystone in the obstetrical ability to successfully manage the antepartum care of the patient and is critically important in the interpretation of antenatal test and successful planning of appropriate therapy and interventions.

Materials and Methods

The study Correlation between gestational age and head circumference in second trimester was carried out at Govt. Medical College and Hospital, Nanded, between July 2011 to July 2013 period. The study included 150 females attending ANC clinic for Ultrasonography screening at Medical College and Hospital. Subjects of the study mainly include urban as well as rural areas in the vicinity.

Inclusion Criteria

1. Women with known LMP
2. Women with regular menstrual cycle
3. Women with singleton and uncomplicated pregnancy
4. Women having age between 18 and 34 yrs.

Exclusion Criteria

1. Women with multiple pregnancies
2. Women with irregular menstrual cycles
3. Women having diabetes mellitus
4. Women with diseases like hypertension, chronic renal disease, heart diseases, iron deficiency anemia. Women having Fetus with congenital anomalies.

For collection of the data proper permission was obtained from ethical committee and radiology department.

1. In this study various particulars of the subjects like age, menstrual and obstetric history had been recorded in the Proforma.
2. The American Institute of Ultrasound in Medicine recommendations were used for measurements of all the fetal parameters.[8]
3. The fetal Head Circumference (HC) was calculated around the outer perimeter of the calvarium. Interpretation of the measurements of fetal Head circumference was done with the help of computer assembled along with the Ultrasound machine. Date of Ultrasonography of subject is recorded and Gestational age of the fetus in terms of weeks was calculated from last menstrual period in the Proforma.
4. The data so collected was then subjected to statistical analysis by expert statistician with the help of SYSTAT Crainsoft version 12 software. Standard statistical methods, parametric methods were used for the evaluation and significance.

Results

The study of Correlation between gestational age and head circumference in second trimester by Ultrasonography was carried out at Govt. Medical College and Hospital Nanded.

The collected data was tabulated according to weeks of menstrual cycle and were taken in centimeters.

Standard deviation of head circumference for each week was calculated. The mean of each parameter calculated statistical for each week. The completed

week considered as the week of gestation. For *e.g.,* 13th week refers to 13.00 to 13.86 weeks of menstrual age. 7 days = 1week, hence 1day = 0.14 weeks. Like this subsequently for each day.

Ultrasongraphic Head Circumference was measured in a total of 150 subjects. The observations of week wise mean values and standard deviation of fetal Head Circumference are shown in (**Table 1)**.

Table 1: Mean and Standard deviations of fetal Head Circumference

(Week wise).

Menstrual age in weeks	No. of cases	Mean	Standard deviation
13	8	9.67	0.78
14	11	10.72	1.24
15	10	12.18	0.76
16	7	13.20	0.44
17	12	13.73	0.66
18	9	14.67	0.76
19	7	16.84	0.82
20	11	16.97	0.70
21	10	18.38	0.97
22	12	19.23	1.94
23	10	20.11	1.93
24	10	21.15	1.29
25	8	21.88	0.88
26	12	22.75	2.41
27	4	24.65	0.73
28	9	24.78	1.64
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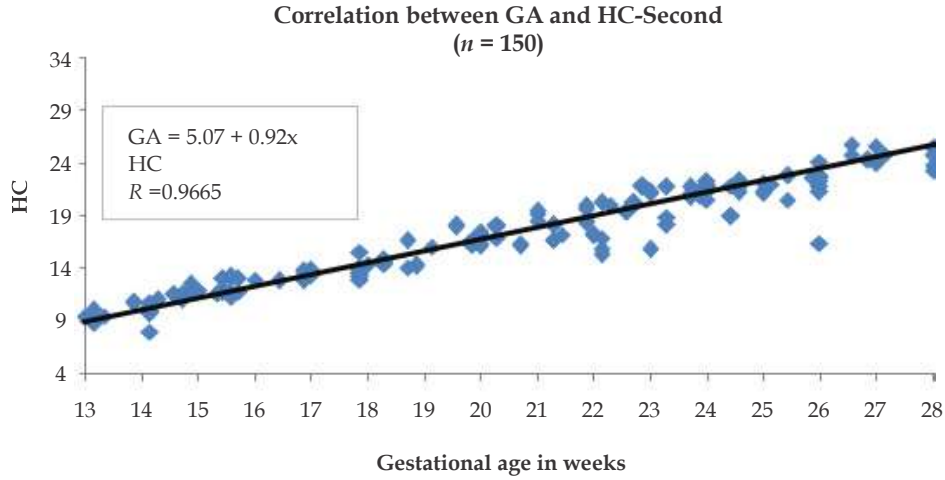

Graph 1: Showing linear correlation between Gestational age and Head Circumference in second trimester (*n* = 150).

Regression output for 2nd trimester (*13 to 28 weeks*)

Constant	= 5.07
Standard error of Y ests	= 0.4787
Co-efficient Of determination (R)	= 0.9665
No. of observations	= 150
Degree of freedom	= 148
X co-efficients	= 0.902

Regression equation:

G.A. = 5.07 + 0.902 x HC

From the above equation it is clear that during the second trimester, for every 1*cm* increase in HC, the gestational age (GA) increases by 0.902 weeks.

As the value of *R* is 0.9665 the variation in fetal growth on the basis of Head Circumference during second trimester can be explained to the extent of 96.65%. The value of *R* is highly significant (Student's '*t*' test value = 149.10, $p < 0.0001$, highly significant) showing that there is statistically positive or strong positive correlation between gestational age and Head Circumference**.**

Discussion

Ultrasonography is key imaging technique in the assessment of fetal growth because of its low cost, availability, and without any adverse effects. Ultrasonography can detect the fine observations of the chorionic sac and its contents during the various stages of fetal and embryonic period. Along with this technique can also detect anomalies abnormality various presentations related fetus at a very early stage. Therefore various advances in Ultrasonography have made this technique a crucial tool for prenatal diagnosis which is a most reliable method for the growth of the fetus.[1]

It is observed that upper extremities almost reach to development by the end of 12th weeks, compare to lower extremities. Appearance of primary ossification centre for cranium and long bones develop by the end of 12 weeks. Various ossification centers can be observed during this period along with bones on Ultrasonography.

Fetal head, body and extremity measurements have been widely reported and found to be used in second and third trimester.[1]After 10th week of gestational period one can differentiate soft and hard tissues after which measurement of various parameters like head circumference other parameter can be done by Ultrasonography which can be recommended.[3]

Studies by Indian authors Vaidya[4] (1986), Khandeparkar[5] (1986), Ghamande[6] (1989), Rajan R[7] (1991) were reflection of the fetal growth parameters in a particular region of India. India being a multi racial country, regional differences in the growth pattern of fetal parameters is expected.

The present study is a cross sectional analysis of fetal growth parameters in 150 subjects was conducted considering the above views. Transabdominal sonography of these subjects was performed and the measurements of fetal growth parameters were recorded in a proforma and subjected to statistical analysis.

The (**Table 2)** shows week wise averages of the measurements of the Head Circumference as studied by Rajan R *et al.*[7] (1991) compared with those calculated in the present study. The present study correlates with the above study**.**

In present study the measurements of Head Circumference are comparable with the findings of various Authors Scammon and Calkins and Kesari, Vare and Bhusari, shows that actual Head Circumference value for human fetuses is very close to value derived in the study.[9] (Shown in **Table 3)**.

Table 2: Showing comparison between week wise mean of the measurements of Head Circumference.

Gestational age	Rajan (1991)	Present study
13	9.1	9.67
14	9.7	10.72
15	11.5	12.18
16	12	13.2
17	13.3	13.73
18	14.3	14.67
19	15.6	16.84
20	16.8	16.97
21	17.5	18.38
22	18.8	19.23
23	19.4	20.11
24	20.5	21.15
25	22.4	21.88
26	23.5	22.75
27	24.1	24.65
28	25.3	24.78

Table 3: Showing comparison between week wise mean of the measurements of Head Circumference.

Gestational age in weeks	Scammon and Calkins (1929)	Vare (1976)	Kesari GV (1979)	Bhusari PA (2010)	Present study
16	11.79	12.30	11.76	13.26	13.20
20	16.68	18.50	17.69	17.13	16.97
24	21.01	24.80	20.69	21.20	21.15
28	24.96	26.30	25.18	26.47	24.78

The regression equations for the Head Circumference derived in the present study are as follows:

HC	2nd Trimester
	G.A. = 5.07 + 0.902 × HC

(Shown in **Graph 1).**

Conclusion

The present study by taking into consideration of Head circumference recorded. This cross-sectional study was carried out on ANC women with age group 18–34 yrs. This study was carried out during the period July 2011 to July 2013 in Govt. Medical College and Hospital Nanded. All the subjects had sound knowledge about their menstrual dates. Data was collected from these subjects with regards to fetal growth parameters and recorded in the proforma.

The collected data was arranged according to the menstrual weeks, by applying various statistical methods mean and standard deviation of the parameter for each week was calculated with software SYSTAT. Comparison of week wise mean value was done with studies done previously and represented in a tabular form and graphical representation of the results was done.

Finally, sonographically measured parameters during second trimesters of pregnancy were subjected to statistical analysis by simple linear regression. The regression was done separately for each parameter and for each week:

1. Head Circumference is found to be statistically highly significant.
2. The regression equations derived for growth parameter for estimating gestational age in a normally developing fetus, increase with gestational age, showed good correlation with gestational age.
3. Assessment of gestational age helped in calculating the EDD (expected date of delivery) in all patients, thus improving the antepartum management. Gestational ages are fairly accurate predictors of fetal growth.
4. In Present study, In second trimester Head circumference is the sensitive parameter and results of present study was comparable with previous studies

References

1. Moore KL. Developing Human Clinically Oriented Embryology, 8th edition. New Delhi (India): Elsevier Publisher; 2008.pp.2–10, 98–105.
2. Dutta DC. Textbook of obstetrics 7th edition. Culcutta (India): New Central Book agency Ltd; 2011.p. 73.
3. Rumack CM, Wilson, Charbonneau. Diagnostic Ultrasound, 3rd edition. Vol. 2; 1991.pp.1069–99.
4. Vaidya PR, Rao GS, Mehedkar, *et al.* Ultrasonic biparietal diameter in Indian women. J. of Obs. and Gynec. of Ind. 1986;26(5):781–83.
5. Raval M, Naik A, Khandeparkar S. Norms of Indian biparietal diameter. Journal of Obstet and Gynec of Ind. 1986 April;36(2):223–25..
6. Ghamande SA, Varawalla NV, Jassawalla MJ, *et al.* Role of ultrasound to determine fetal gestational age. J of Obstet and Gynaecol of India. 1989;13:605–08.
7. Rajan R, Girja B, Vasntha R. Ultrasound determination of fetal growth parameters and gestational age. J of Obs. and Gynec. of India. 1991 Feb;41(1):139–45.
8. AIUM Practice Guideline for the Performance of Obstetric Ultrasound Examinations ©2007 by the American Institute of Ultrasound in Medicine. URL:Http://www.aium.org/publications/guidelines/obstetric.pdf
9. Bhusari PA, Chormunge PVB, Kamkhedkar SG, *et al.* To determine accuracy and reliability of ultrasonographic measurements and to demonstrate correlation of parameters with each other. Pravara Med Rev. 2010;5(4):18–21.

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[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, *et al.* Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347-55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3-9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792-801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O,

Kidd EAM, editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 7-27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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