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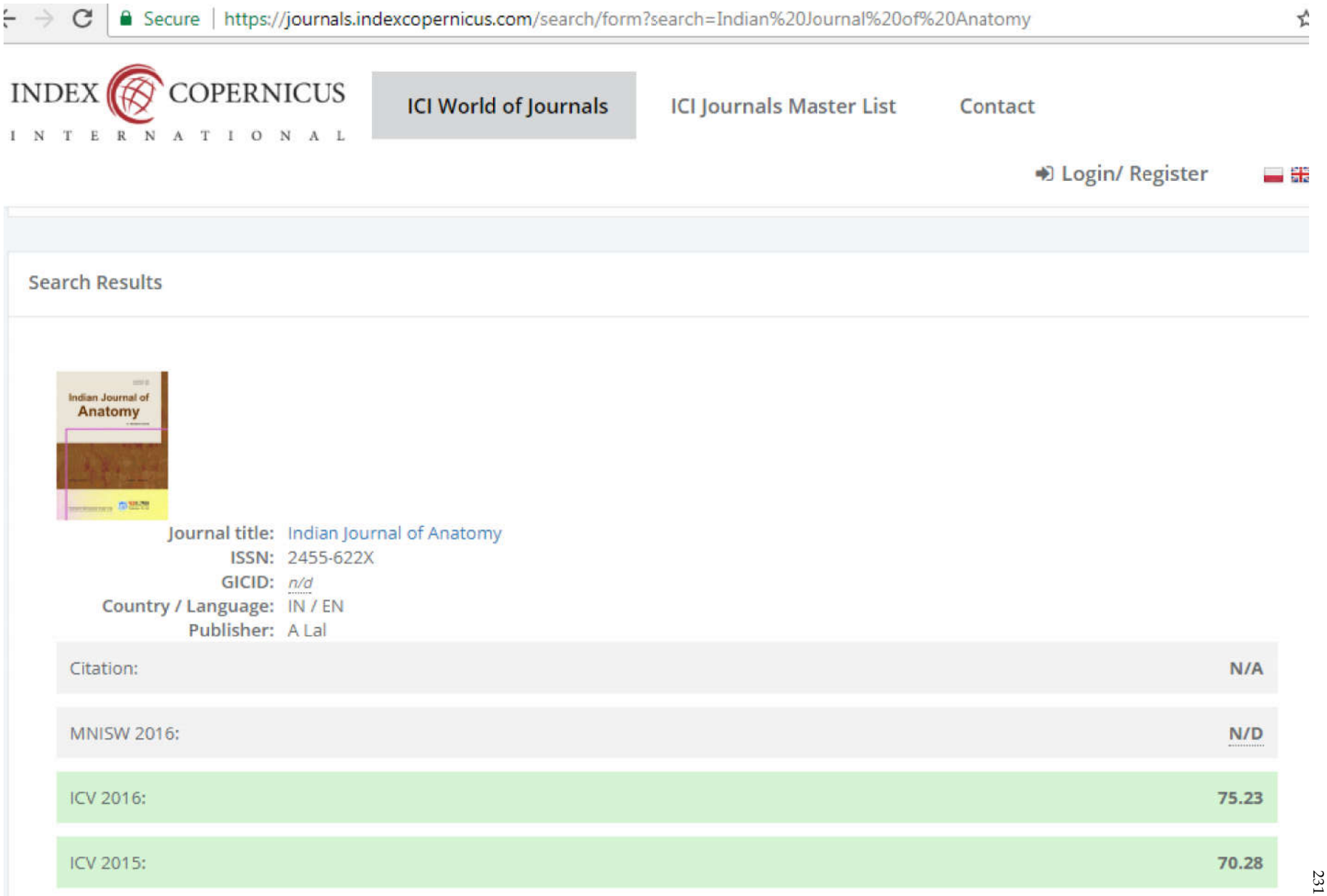
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Original Article

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Morphometric Study of Glenoid Cavity of Human Scapula

Ghule Shubhangi B.[1], Wagh Kailash B.[2], Mahajan Amrut A.[3]

Abstract

Introduction: Present study aims to determine the various dimensions of the glenoid cavity and to note the variation in its shape. *Material and Methods:* 123 dry, adult human scapulae were used for present study. Out of which, 60 belong to right side and 63 on left side. Length and breadth of glenoid cavity were measured by using the vernier caliper. Glenoid cavity index was calculated. We also noted the different shapes of glenoid cavity. *Results:* In present study, most common shape of glenoid cavity was pear shaped (51.22%) followed by inverted comma shaped (34.15%), followed by oval shape (14.63%). The average length of glenoid cavity on right side was 35.55±3.48 mm and on left side was 35.04±3.61 mm. The average breadth of glenoid cavity on right and left side were 22.51±2.51 mm and 22.81±2.88 mm respectively. Mean glenoid cavity index on right side was 63.62±6.73% and that of left side was 65.19±6.44%. *Conclusion:* Anatomical knowledge of shapes and dimensions of glenoid cavity are important for orthopaedic surgeons, anatomists, anthropologists and forensic experts.

Keywords: Glenoid Cavity; Glenoid Cavity Index; Shape of Glenoid Cavity.

Introduction

The scapula is a thin and flat bone placed on the posterolateral aspects of the thoracic cage. It has three angles, superior, inferior and lateral angle. The lateral angle is broad and truncated which bears the glenoid cavity also known as glenoid fossa, directed forwards, laterally and slightly upwards. The capsule of shoulder joint is attached along the margins of the glenoid cavity. The shoulder joint is formed by articulation of the glenoid cavity and head of humerus. The shoulder joint is more prone to dislocation than any other joint because of laxity of the capsule and the disproportionate area of the articular surfaces.

Knowledge of morphometry of glenoid fossa is essential for treating glenohumeral osteoarthritis [1]. The glenoid rim presents a notch in its anterosuperior part, due to which various shapes of glenoid cavity are described like pear shaped, oval or inverted comma shape [2-4]. The anatomical basis and variation of shape and size of glenoid cavity of scapula is of fundamental importance in understanding the rotator cuff disease, shoulder dislocation and to decide the proper size of the glenoid component in the shoulder arthroplasty [5]. Present study aims to determine the various dimensions of the glenoid cavity and to note the variation in its shape.

Material and Methods

The present study was conducted on 123 dry, adult human scapulae (60–right side and 63-left side) collected from students of First year MBBS, BPTH and from Dept of anatomy Dr. Ulhas Patil Medical College, Jalgaon. Out of which 60 were of right side and 63 of left side.

All the bones were fully ossified, dry and without any damage. The Length and breadth of glenoid cavity were measured by using the vernier caliper. We also noted the different shapes of glenoid cavity like pear-shaped, inverted comma and oval shaped (Figure 1). Glenoid cavity index was calculated in percentage by using the following formula,

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$$\text{Glenoid cavity index} = \frac{\text{Maximum breadth of glenoid cavity}}{\text{Length of glenoid cavity}} \times 100$$

Inverted comma shape Oval shape Pear shape

Fig. 1: Different shapes of glenoid cavity

Fig. 2: Dimensions of glenoid cavity

Following measurements were taken in milimetres.

i. Length of glenoid cavity (Figure 2) – It was taken from most prominent on the supraglenoid tubercle to the inferior margin of glenoid cavity. It was measured from point a to b.

ii. Breadth of glenoid cavity (Figure 2) – It was taken along the maximum breadth of the articular margin of the glenoid cavity perpendicular to glenoid cavity height. It was measured from point c to d.

Results

All the parameters were studied and analyzed by using standard computer programme. Range, mean and standard deviation were calculated for each parameter. The analyzed data was tabulated as follows –

Table 1 shows that majority of bones had pear-shaped glenoid cavity (51.22%), followed by inverted comma shaped (34.15%), followed by oval (14.63%).

Table 2 shows that the average length of glenoid cavity on right side was 35.55±3.48 mm and on left side was 35.04±3.61 mm. The average breadth of glenoid cavity on right and left side were 22.51±2.51 mm and 22.81±2.88 mm respectively. Mean glenoid cavity index on right side was 63.62±6.73% and that of left side was 65.19±6.44%. p value more than 0.005 shows that there were no significant difference between right and left side.

Table 1: Different shapes of glenoid cavity

Shape	Right side		Left side		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Pear	30	50	33	52.38	63	51.22
Inverted comma	18	30	24	38.10	42	34.15
Oval	12	20	6	9.52	18	14.63

Table 2: Observations of various dimensions of glenoid cavity

Parameter	Range		Mean ± SD		t value	p value
	Right	Left	Right	Left		
Length (mm)	27-42	27-43	35.55±3.48	35.04±3.61	0.78	0.43
Breadth (mm)	17-30	17-30	22.51±2.51	22.81±2.88	0.60	0.54
Glenoid cavity index (%)	48.8-79.3	42.9-81.1	63.62±6.73	65.19±6.44	1.33	0.18

Discussion

In present study various shapes and dimensions have been measured and compared with findings of previous workers showed in Table 3 and Table 4. Present study correlates with other studies.

In present study mean length of glenoid cavity on right side was 35.55±3.48mm and on left side was 35.04±3.61mm. The mean of breadth of glenoid cavity on right and left side were 22.51±2.51mm and 22.81±2.88mm respectively.Our findings of dimensions of glenoid cavity are nearer to the findings of Mamatha T. et al. (2011)[6], Rajput HB et al. (2012)[7], Sinha P. et al. (2016)[8] and Jawed Akhtar Md et al. (2016)[9] studies.

In an another study by Chhabra N. et al.(2015) [5], they observed slightly higher values than present study. The mean glenoid cavity index found in our study was 63.62±6.73% on right side and 65.19± 6.44% on left side. Our findings more or less similar to Chhabra N. et al.(2015)[5] and Jawed Akhtar Md et al.(2016)[9] studies.

In present study pear-shaped glenoid cavity was found in 50% of sample of right side and 52.38% of the left side followed by inverted comma shaped found 30% in right side and 38.10% in left side, followed by oval shaped found 20% in right side and 9.52% in left side. Our findings similar with Mamatha T. et al.(2011)[6], Rajput HB et al.(2012)[7] and Jawed Akhtar Md et al.(2016)[9] studies.

They observed majority of bones had pear shaped glenoid cavity followed by inverted comma followed by oval shaped. But our study does not correlate with Chhabra N. et al.(2015)[5] and Sinha P. et al.(2016) [8]studies.

They reported pear shaped glenoid cavity was most common followed by oval shaped and inverted comma shaped was least common.

Conclusion

The knowledge of different shapes and dimensions are useful to orthopaedic surgeons for arthroplasty, reduction of dislocation, treatment of arthritis and rotator cuff disease, etc.

It is also useful to anatomists, anthropologists and forensic experts. Anatomical knowledge of glenoid is important to evaluate the pathological conditions like osseous Bankert lesion and osteochondral defects.

Table 3: Comparison between previous and present study on glenoid cavity

Author	Mean ± SD					
	Length(mm)		Breadth(mm)		Glenoid cavity index (%)	
	Right	Left	Right	Left	Right	Left
Mamatha T. et al.(2011) [6]	33.67±2.82	33.92±2.87	23.35±2.04	23.05±2.30	-	-
Rajput HB et al.(2012) [7]	34.76±3.0	34.43±3.21	23.31±3.0	22.92±2.80	-	-
Chhabra N. et al.(2015) [5]	38.46±2.81	39.03±3.18	25.04±2.69	24.85±2.46	65.11±5.11	63.67±3.76
Sinha P. et al. (2016) [8]	33.64±3.01	34.44±3.27	23.22±2.85	23.31±3.12	-	-
Jawed Akhtar Md et al.(2016) [9]	36.03±3.15	35.52±3.12	23.67±2.53	23.59±2.47	66.13±8.67	66.73±7.47
Present study (2018)	35.55 ± 3.48	35.04 ±3.61	22.51 ± 2.51	22.81 ± 2.88	63.62 ± 6.73	65.19 ± 6.44

Table 4: Comparison between previous and present study on different shapes of glenoid cavity

Author	Side	Shape		
		Pear shape (%)	Inverted comma (%)	Oval (%)
Mamatha T et al. (2011)[6]	Right	46	34	20
	Left	43	33	24
Rajput HB et al.(2012) [7]	Right	49	35	16
	Left	46	39	15
Chhabra N. et al.(2015) [5]	Right	47	22	31
	Left	55	13	32
Sinha P. et al. (2016) [8]	Right	23	9	08
	Left	42	6	13
Jawed Akhtar Md et al.(2016) [9]	Right	51.59	34.92	13.49
	Left	49.02	37.25	13.73
Present study (2018)	Right	50	30	20
	Left	52.38	38.10	9.52

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Original Article

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Morphometric Variations in Spleen: A Study in Dissected Cadavers in Anatomy Department of a Teaching Hospital of India

Divya Agrawal[1], G.B. Sujatha[2], Biswa Bhusan Mohanty[3], V. Subhashini Rani[4]

Abstract

Introduction: The spleen is a large lymphoid organ situated mainly in left hypochondrium wedged between the fundus of stomach and the diaphragm. The spleen serves a large number of functions in humans starting from fetal life & continuing till adulthood. It is the site for manufacture of erythrocytes in fetus & takes up the immunological function in adult life. A large number of variations are observed in the morphology of spleen like different shapes, sizes, notches in the inferior border, accessory spleens etc. In present day medical practice, the stress is on non- invasive procedures& imaging techniques for various diagnosis and treatment. So, a thorough knowledge of the anatomy & variations observed in splenic morphology becomes very important. *Materials & Methods:* A total of 36 spleens of both sexes which were obtained during routine dissection classes of undergraduate MBBS students were included in this study. These spleens were removed from the cadavers by standard dissection method. *Observations & Results:* In our study, five different shapes of spleen were observed. Among them the commonest was wedge shaped (41.66%) and the least common was irregular shape (5.55%). The average length of spleen found is 10.152 cm, breadth is 6.014 cm & thickness is 3.236 cm. The average weight of our spleen in our study was 156.01 gms. One case of accessory spleen was seen in this study. *Conclusion:* Study and documentation of these variations is important for surgeons and radiologists who are going for surgeries and imaging studies.

Keywords: Spleen; Accessory Spleen; Notched Spleen; Shapes.

Introduction

The spleen is a large encapsulated haemolymphoid organ situated in the left hypochondrium & partly in the epigastrium. It is placed between the fundus of stomach & diaphragm opposite to the 9th to 11th ribs. It is a very vascular, soft and friable organ which is purple in colour and moves with respiration.

The size and weight of spleen is different in different age groups [1]. In adults, it is usually 12 cm in length, 7cm in breadth and 3-4 cm in width. Its weight ranges between 80-300gm with an average of around 150 gm [1,2].

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The spleen presents two ends- medial & lateral, two surfaces-diaphragmatic and visceral, two borders- superior & inferior and two angles- anterior basal & posterior basal [3. The diaphragmatic surface is smooth & convex whereas visceral surface presents impressions for the stomach, left kidney, left colic flexure & tail of pancreas [3]. The superior border is important as it presents with notches which indicates that spleen is lobulated in development. The posterior pole is directed towards the vertebral column & the anterior pole is broad & faces laterally [3].

The spleen is surrounded by peritoneumwhich passes from its hilum to fundus of stomach as gastrosplenic ligament and to left kidney as lienorenal ligament [3]. Accessory spleens may be found in the hilum, gastrosplenic ligament, lienorenal ligament, in greater omentum, along splenic vessels & very rarely scrotum [4].

Its incidence varies from 10-30% in autopsy series [5,6]. The spleen serves a large number of functions in humans starting from fetal life & continuing till adulthood. It is the site for manufacture of erythrocytes in fetus & takes up the immunological function in adult life. It filters the unwanted elements from blood

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by phagocytes. Ageing or abnormal RBCs are also destroyed by the spleen & thus it serves as the graveyard of RBCs [3].

As the spleen has an open type of circulation,blood borne antigens have a direct access to splenic lymphatic tissue which can be phagocytosed by red pulp macrophages. Thus the spleen performs both haematological & immunological functions.

Splenectomy is a surgical procedure which involves removal of spleen either partially or completely. This is indicated in conditions like splenic rupture after trauma, lymphomas, cysts ,hypersplenism etc. The present surgeon always tries to preserve as much splenic tissue as possible because its removable diseases immunity. Thus a sound knowledge of the various morphological variations in anatomy of spleen becomes important. With this in mind, a study of splenic morphology was taken up.

Materials & Methods

The present study was conducted in the Dept. of Anatomy, GSL Medical College and General Hospital, Rajamahendravaram, Andhra Pradesh. A total of 36 spleens of both sexes which were obtained during routinedissection classes of undergraduate MBBS students were included in the study. These spleens were removed from the cadavers by standard dissection method. They were separated from the nearby structures & the vessels were ligated & cut near the hilum. Then they were washed with tap water to remove all fat & other tissue attached to them. They were weighed on scale& then morphometric measurements were taken using calipers and tape. As suggested by Michels [7] the greatest distance between 2 poles is taken as length, the greatest distance between two points at same level on superior & inferior border as breadth & the greatest breadth of spleen. Also an observation over the surfaces, notches on borders, presence of accessory spleens & visceral impressions was made.The data obtained was tabulated, statistically analysed & compared with previous authors.

Observations and Results

Table 1 shows various shapes of spleen seen in our study. The most common shape seen was wedge shape. The wedge-shaped spleen accounted for 41.67% of the total count. Table 2 shows that the weight of spleen varied from a minimum of 70 gms to a maximum of 300gms. Most of the spleens weighed between 141-200gm. The average weight of the spleen was 156.01gms.

The length of spleens varied between 4.5 cm and 13 cm with mean length being 10.152cm. The width of spleen varied from 3cm to 10 cm with a mean of 6.01388cm. The thickness of spleen ranged from 1.5 -6 cm with an average width of 3.236 cm.

Fig. 1: Wedge Shaped Spleen with Its Pedicle

Table 1: Shapes of spleen in our study expressed as percentages

Shape of Spleen	Expressed as %
Wedge	41.67%
Tetrahedral	27.7%
Oval	16.67%
Triangular	8.33%
Irregular	5.56%

Table 2: Tabulation of various spleen specimens according to weight

Weight of Spleen (Range)	No. of Specimens	Percentage
<70 gms	3	8.34%
70-140 gms	17	47.23%
141-200gms	11	30.56 %
201-250 gms	3	8.34%
251-300 gms	2	5.56%

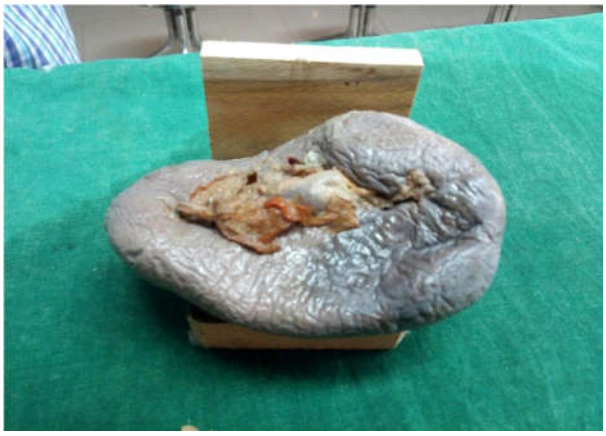

Fig. 2: Wedge Shaped Spleen with Its visceral impressions

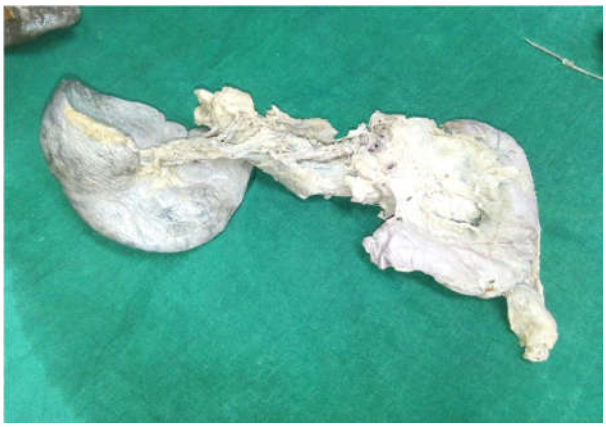

Fig. 3: Tetrahedral Spleen removed along with Pancreas and duodenum

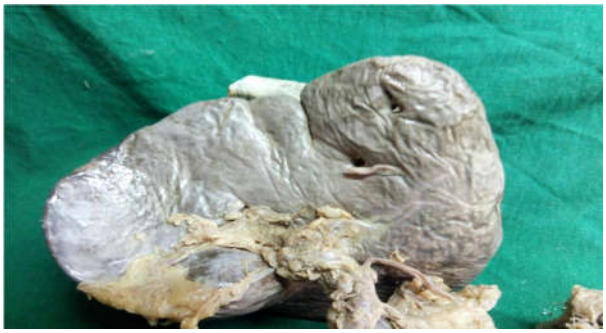

Fig. 4: Tetrahedral Spleen with numerous notches on the superior border

Fig. 5: Oval Spleen with notched inferior border

Fig. 6: Triangular spleen showing visceral surfaces

Fig. 7: Accessory spleen present in the greater omentum

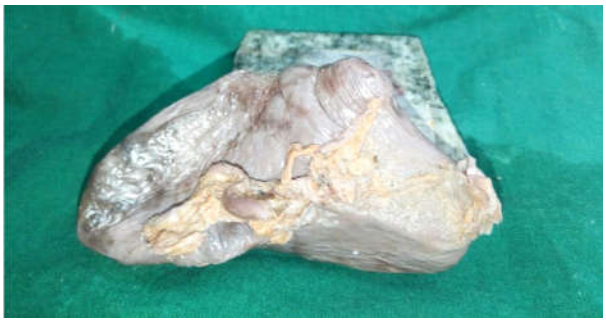

Fig. 8: Irregular spleen with multiple notches at the upper border

Fig. 9: Spleen with multiple notches at the upper border

Out of 36 spleens, 27 showed notches. All of these spleens showed notches in the superior border which were 2-6 in number. 5 of these also showed notches in the inferior border.

One case of accessory spleen was also seen. It was seen to be present in the greater omentum.

Discussion

In present day medical practice the stress is on non invasive procedures& imaging techniques for various diagnosis and treatment. So, a thorough knowledge of the anatomy & variations observed in splenic morphology becomes very important.

In our study, five different shapes of spleen were observed. Among them the commonest was wedge shaped (41.66%) and the least common was irregular shape (5.55%). This is in accordance with findings of [2,7] in which the wedge shaped spleen was found in 44% of subjects. In a study done by Chaware [8] in Maharashtra 61.26% of spleens were wedge shaped, 21.62% were tetrahedral ,12.61% triangular in shape, 3.60 % wereoval & 0.9% were irregular.

The average weight of our spleen in our study was 156.01 gms which is very close to that obtained by Chaware who reported it as 145.76 gms. The average length of spleen found is 10.152 cm , breadth is 6.014 cm & thickness is 3.236 cm. This is similar to the findings of Sugat G Kawale et al. who reported length as 9.66 cm, width as 6.22 cm & thickness as 3.06 cm respectively. The variations observed in different studies can be due to differences in bodyconstituition, geographical conditions, genetic factors, dietary habits and socioeconomic conditions.

The spleen develops in the left layer of dorsal mesogastrium in the form of lobules which later fuse with one another. This lobulated development of spleen is indicated by notched upper border [9]. Notches were observed mainly in the superior border, but 5 spleens also showed notches in inferior border. Satheesha Nayak et al. [10] in her study observed that out of 50 spleens studied, 25 spleens had notches & 25 did not have any notches. The number of notches observed were 2-6. This is in accordance with study by other workers [2,7]. One case of accessory spleen was seen in this study. Some researchers [4,12] have reported the incidence of accessory spleens ranging from 10-35%. The knowledge of presence of accessory spleen is important as they may be located in the gastrosplenic ligament, greater omentum, pancreas etc. and may be left behind during splenectomy. This will result in failure of the indication for splenectomy like in splenic anemia [12].

Conclusion

The present study makes us feel that the study of spleen and its morphological variation in a south Indian population is very crucial to perform safe and effective surgeries. Presence of notches in the inferior border occasionally should become a part of splenic morphology and must be mentioned in standard anatomy textbooks. This variation is important for surgeons and radiologists who are going for surgeries and imaging studies. These variations should be kept in mind during routine clinical examination of abdomen like in splenomegaly and splenic traumas.

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Original Article

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Histochemical Characteristics of Mucosubstances in Normal Human Mammary Gland

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Abstract

Introduction: Mucins implicated in cancers of various organs. The apical epithelial surfaces of mammalian respiratory, gastrointestinal, and reproductive tracts are coated by mucus, a mixture of water, ions, glycoproteins, proteins, and lipids. The purpose of this study was to confirm the presence of mucin production using Haematoxylin and Eosin (H&E) stain as the gold standard and to describe the types of mucins using various types of histochemical techniques. *Method:* This is a retrospective, observational, analytical, case control study aimed to evaluate mucins histo-chemical pattern in normal human breast. Twenty five histologically proven normal human breast tissue were taken.Tissue sections were stained by Mayer's Haematoxylin and Eosin, PAS, PAS-diastase, Phenylhydrazine-PAS, Alcian blue 2.5, Alcian Blue 1, combined alcian blue-PAS, Aldehyde Fuschin and combined aldehyde fuchsin-alcian blue techniques. *Result:* The human mammary gland showed the presence of neutral mucins and acidic mucins. In acidic mucins sialomucins were present and sulfomucins were recorded in trace amount. This concludes that mucin histochemical patterns have valuable, cost-effective, and important role where a slight change in the mucin pattern may help in the early diagnosis of the disease process.

Keywords: Mammary Gland; Mucosubstances; Special Stains; Breast Mucins.

Introduction

The mammae exit in both sexes.In male they are rudimentary throughout life; in the female they are underdeveloped before puberty but undergo considerable growth and elaboration at and after puberty.In the lateral plane its base extends vertically from the second to the sixth rib, andat the level of the fourth costal cartilage it extends transversely from the side of the sternum to near the midaxillary line [1].

Histologically, mammary glands are modified tubuloalveolar apocrine sweat glands. The tubuloalveolar mammar glands, derived from modified sweat glands in the epidermis, lie in the subcutaneous tissue. The inactive adult mammary gland is composed of fifteen to twenty irregular lobes separated by fibrous bands of connective tissue [2]. These alveoli secrete Mucosubstances which performs a wide variety of functions like lubrication, protection against acids, maintenance of hydration etc. They also contain immunoglobulin's mainly IgA type, lactoferrins which chelate the iron necessary for growth of some bacteria and lysozymes which destroy some of bacteria. The mucins play an important role defense against bacteria. Sulphomucins are acting as antiulcerogenic as they coat and protect mucosal surface while neutral mucins help for secretion of enzymes [3]. Many workers like Soo Youn Bae [4], D. J. Cooper [5], Muaz Osman [6], S.S. Spicer [7], Partho Mukhopadhyay [8] have studied the mucosubstances of human mammary gland but few have studied about the mucin histochemical characteristics in normal human breast tissue.So the present study has been undertaken and correlated with previous workers [4-8].

Material and Methods

Histologically proven, twentyfive normal human mammary glands were obtained during autopsies and routine dissection.

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The tissue was fixed in 10% formalin with 2% Ca acetate. By routine procedure paraffin blocks were prepared and 4-5 micron thick sections were cut.

They were stained by .9-11

1. Haematoxylene and Eosin (H & E).
2. Periodic Acid- Schiff (PAS).
3. Periodic Acid- Schiff with diastase digestion (PAS-D).
4. Periodic Acid- Schiff with phenyl hydrazine (PAS-PH).
5. Alcian blue 2.5 pH (AB 2.5 pH).
6. Alcian blue 1 pH (AB 1 pH).
7. Combined AB-PAS.
8. Aldehyde fuschin (AF).
9. Combined AF-AB.

All the results were tabulated according to colour intensity into different grades ranging from + to ++++.

Colour Index

1. ++++ : Very strong positive reaction.
2. +++ : Strong positive reaction.
3. ++ : Moderate reaction.
4. + : Weak reaction.
5. No staining : Negative reaction

The slides were photographed using digital camera.

The histochemical data staining methods employed in the present work are recorded according to visually estimated intensity of staining and shades withfour plus representing strongest activity. Nomenclature applied to the mucosubstances is taken from the discussion of a proposed general terminology of histochemically recognized material [12,13]. Histochemical results requiring further description and consideration are presented here along withtheir interpretations.

Observation and Results

Sections studied showed few atrophic glands surrounded by dense connective tissue. The epithelial component shows branching duct system to form a lobule. Also are seen numerous adipose cells.The epithelial cells lining the ducts are cuboidal to columnar and exhibit interspersed lymphocytes that have entered the epithelium (Figure 1).

When the sections of mammary gland are stained with PAS stain, it was found that the ducts and lobules are stained with magenta showing the presence of PAS positive substances like carbohydrate and neutral mucins (Figure 1).

With diastase digestion the magenta colour intensity was reduced indicating the presence of non-mucinous carbohydrates like glycogen (Figure 1). PAS-PH showed decrease of colour intensity indicating presence of neutral mucins. Few cells show presence of acidic mucins also. (Figure 2). AB 2.5 pH stained dark blue which confirms the presences of both types of acidic mucins. (Figure 2). When stained with AB 1 pH very few acini are stained showing presence of very few sulfomucins (Figure 2). With AF, it showed very low colour intensity, so the presence of trace amounts ofsulfomucins is confirmed (Figure 3). With combined AB-PAS staining show varied colour intensity. Many are intensely stained with magenta colour with few blue acini.It indicates the presence of combination of acidic and neutral mucins. (Figure 3). AF-AB stained blue showing presence of sialomucins while very few are stained purple which confirms the presence ofvery few sulfomucins (Figure 3).

Table 1: Showing results of Mammary gland staining

No.	Stain	Intensity	Inference
1	H&E	-	Glands surrounded by dense connective tissue
2	PAS	++++	Presence of PAS positive substances i.e. carbohydrates and neutral mucins.
3	PAS-D	++	Presence of glycogen.
4	PAS-PH	+ / -	Presence of large amount of neutral mucins.
5	AB 2.5	+++	Presence of acidic mucins.
6	AB 1	+	Presence of sulfomucins in trace amount.
7	AF	+	Confirms presence of sulfomucins
8	AB–PAS	Magenta +++ Blue ++	Presence of neutral and acidicmucins.
9	AF-AB	Blue ++ Purple +	Confirms presence of sialomucins with trace amounts of sulfomucins.

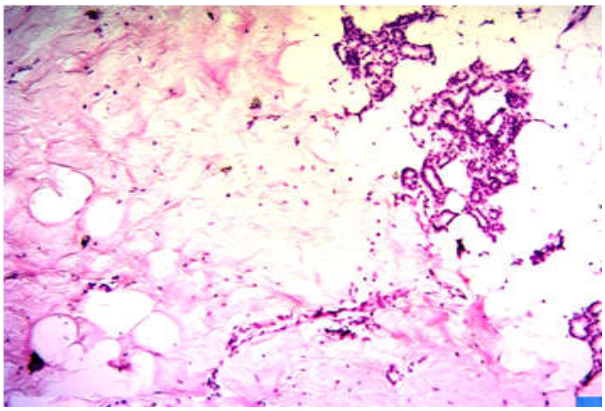

Fig. 1: Histology of normal mammary glands Inactive stage Photomicrograph 1 (H &E,10X)

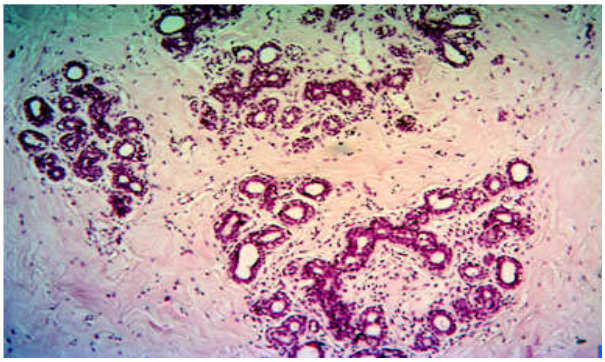

Fig. 2: PAS Photomicrograph 2 (H &E,10X)

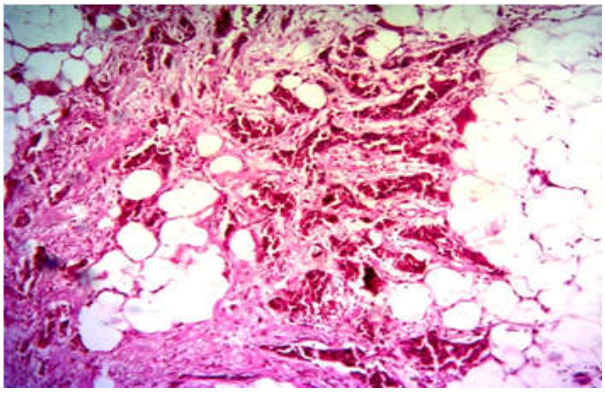

Fig. 3: PAS D Photomicrograph 3 (H &E,10X)

Fig. 1-3: Histology of normal mammary glands

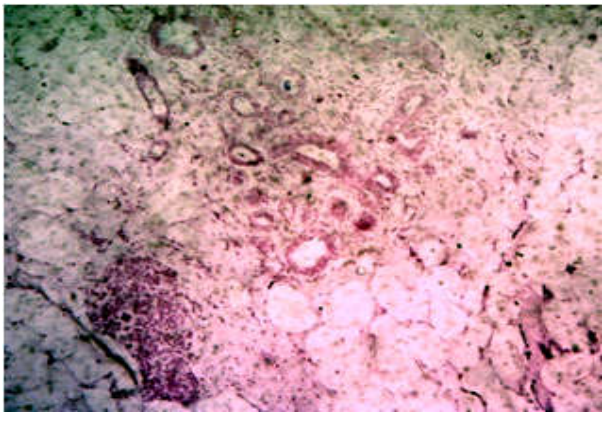

Fig. 4: PAS PH Photomicrograph 4 (H &E,10X)

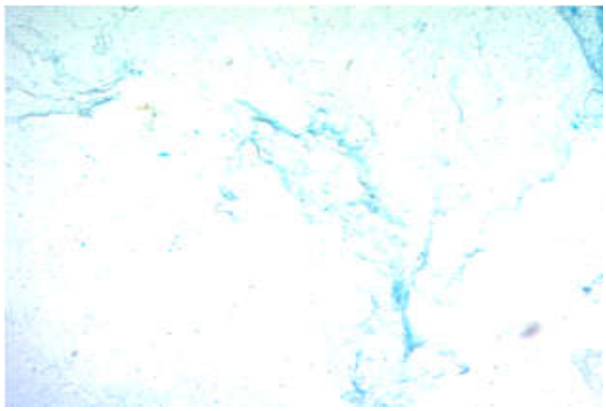

Fig. 5: AB 2.5 Photomicrograph 5 (H &E,10X)

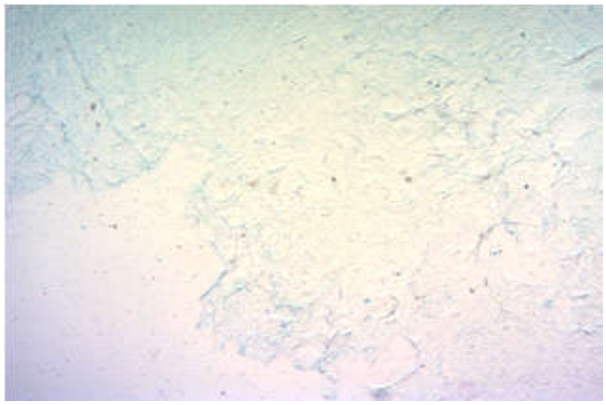

Fig. 6: PAS 1 Photomicrograph 6 (H &E,10X)

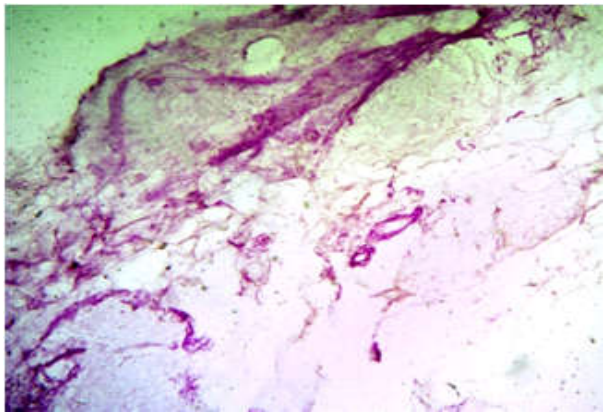

Fig. 7: AF Photomicrograph 7 (H &E,10X)

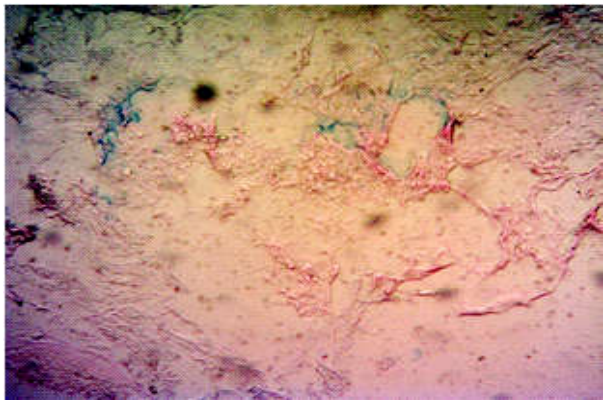

Fig. 8: AB PAS Photomicrograph 8 (H &E,10X)

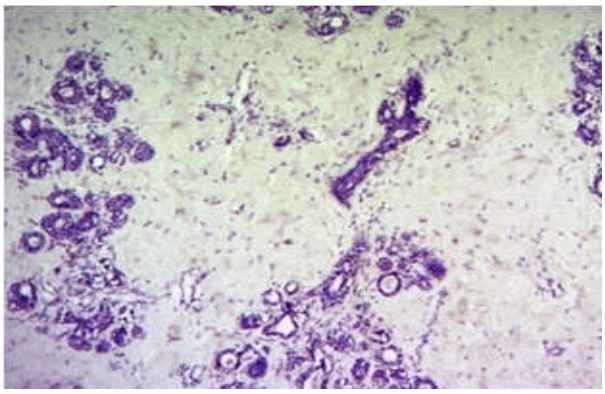

Fig. 9: AF AB Photomicrograph 9 (H &E,10X)

The results are tabulated in Table 1. From the Table 1 we can say that the mammary gland shows presence of both neutral and acidic mucins. In that also neutral are more and in acidic sialomucins are more than sulfomucins.

Discussion

Mucopolysaccharides occur in many epithelial tissues (ref 5-discussion). These substances vary greatly in chemical composition, as evidenced bythe large number of categories recognized biochemically [14] and the pluralityof their histochemical properties [15-20]. Thus neutral mucopolysaccharides can be distinguished histochemically from those containingacidic moieties [21,22]; in the latter category Inucins, in which the acidgroup is a sulfate ester [23-26], can be differentiated from those containingside groups terminating with sialic acid [27].

Displaying also a greatvariety of morphologic manifestations, mucins are found distributed uniformly throughout the cytoplasm in some glands, localized to gobletsin, various simple epithelia, restricted to superficial epithelial cells incertain stratified epithelia, and limited to the cell surface or the lumen ina number of glands.

Mucins are high molecular weight glycoproteins that are found dispersed (thesis) throughout the epithelia of the gastrointestinal, respiratory and reproductive tract [28].

The term mucosubstances is used, as recommended by Spicer, Leppi and Stoward (1965), to denote all tissue components other than glycogen, rich in carbohydrates, which are present in connective tissue or as secretion of certain epithelial structures [29]. Connective tissue mucosubstances are called "mucopolysaccharides", while those secreted by epithelia are referred as "mucins" [30].

Mucins are a family of high molecular weight, heavily glycosylated proteins (glycoconjugates) produced by epithelial tissues in most metazoans. 'Mucins' key characteristic is their ability to form gels; therefore they are a key component in most gel-like secretions, serving functions from lubrication to cell signalling to forming chemical barriers. They often take an inhibitory role [31].

Mucins are altered in normal and pathological states so it is of ever increasing importance in the investigation of normal and disease process.

In the present study when the sections of mammary gland are stained with PAS stain, it was found that the ducts and lobules are stained with magenta showing the presence of PAS positive substances like carbohydrate and neutral mucins.

With diastase colour intensity was reduced indicating the presence of non-mucinous carbohydrates like glycogen.

PAS-PH showed presence of neutral mucins. Few cells show presence of acidic mucins also.

AB 2.5 pH confirms the presences of both types of acidic mucins. With AB 1 pH very few acini are stained showing presence of very few sulfomucins.

With AF, trace amounts of sulfomucins is confirmed. Combined AB-PAS staining indicates the presence of combination of acidic and neutral mucins.

AF-AB stained blue showing presence of sialomucins.

In normal mammary gland, the acini are positively stained with PAS indicating the presence of PAS positive substances like carbohydrates and neutral mucins. Few of the acini are negative for PAS staining which may contain enzymes or some of the sulfomucins which are PAS negative.

These results are in accordance with the study ofLuciano Ozello. Reduced magenta color intensity after diastase digestion shows the presence of non-mucinous carbohydrates also. PAS-Ph is non-reactive indicating the presence of large amount of neutral mucins.

Strong positivity for AB 2.5 but negativity to AB 1 pH and AF. It shows presence of both types of acidic mucins but in that sulfomucins are present in very much trace amounts. These results are in accordance with the study of S. S. SPICER. The combined AB-PAS and AF-AB also showed the acini positive for AB and PASindividually indicating the presence of both neutral and acidic mucins in equal amounts.

Conclusion

The human mammary gland showed the presence of neutral mucins and acidic mucins. In acidic mucins sialomucins were present and sulfomucins were recorded in trace amount. Any change in the mucin pattern may be helpful in the early diagnosis of any disease process.

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CT Evaluation of Chamberlain's and Mcrae's Lines and its Significance in Relation to Skull Base Problems at Meenakshi Medical College and Hospital

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Abstract

Introduction: The odontoid process is the central pillar of craniovertebraljunction. It is assessed by lateral cervical spine and base of skull radiographs which however have diagnostic challenges due to the complexity of the anatomy. Modern-day Computed Tomography (CT) offers excellent bony detail and its ability to reconstruct the acquired CT data into various imaging planes makes the assessment of the cranio-cervical junction easy and more accurate. The standard skull base lines (Chamberlain's and McRae's lines) are used in the evaluation of the craniovertebral junction. They help to illustrate the degree of deformity in patients with basilar impression and aid in surgical decisions with regard to decompression, fixation and stabilization. These measurements are also used as guides in the conservative follow up of patients or those who are surgically managed. *The Aim of The Study:* To evaluate the relationship of the odontoid tip of C2 to the standard skull baselines of Chamberlain's and McRae's on computed tomography in symptomatic and asymptomatic patients. *Materials and Methods*: Reformatted midline sagittal CT images of 150 patients (M-68,F-82) were retrospectively evaluated. The shortest perpendicular distance was measured from the Chamberlain's and McRae's baselines for each subject to the odontoid tip. *Results:* The most common age group in male is 41-50 and female 31-40 years. The mean position of the odontoid process was 2.65 mm below Chamberlain's line (median 2.7 mm, SD 0.21mm) and 4.6 mm (median 4.6 mm, SD 0.19 mm) below McRae's line.There was no statistically significant difference in measurements between male and female patients. *Conclusion*: Imaging of this small structure to reach a specific diagnosis continues to be a challenge for radiologists. Multiplanar imaging with CT allows more detailed evaluation of bony and soft tissue structures. Adequate knowledge of development, complex anatomy, various disease processes, topographic relationships of odontoid with respect to CVJ and craniometry in association with the appropriate clinical background can provide a meaningful diagnosis. These results provide the mean of normal distance from the odontoid process to the standard skull base lines on CT. This study can be used as a base line data to access skull base problems.

Keywords: Reformatted Midline Sagittal CT; Chamberlain's; McRae's Lines; Odontoid Process.

Introduction

The craniocervical junction consists of the bone that forms the base of the skull (occipital bone) and the first two bones in the spine, the atlas and axis. Disorders that affect theforamen magnum are a particular concern because important structures pass through this opening. The following structures in the foramen magnum are lower end of medulla oblongata and the meninges, vertebral vessels surrounded by sympathetic plexus of nerves, spinal root of accessory nerve, anterior and posterior spinal arteries and occasionally tonsil of cerebellum on either side of brain stem. Disorders that put pressure on the lower parts of the brainstem, upper part of the spinal cord or nearby neurovascular structuresand malalignment of the first and second spinal bones (atlantoaxial subluxation or dislocation) result in paralysis, weakness, difficulty sensing vibration, pain, temperature, dizziness, and impaired vision [1]. Anatomical evaluation of the craniocervical junction has improved significantly since the advent of multiplanarcomputerized tomography (CT). The capability to reconstruct transverse cuts into axial, sagittal, coronal and oblique reformats has enhanced

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ability to assess craniocervical junction deformities. CT imaging also allows accurate measurements of classical lines and angles, transverse and AP diameters of the foramen magnum and spinal canal. The odontoid process is a part of the C2 or axis vertebra and forms the pivot of the structures forming the craniovertebral junction (CVJ). The pathologies of odontoid can be congenital or acquired. Congenital anomalies include various types of odontoid dysgenesis such as osodontoideum, condylustertius, persistent os-terminal, and odontoid aplasia [2].

Acquired anomalies of odontoid may be traumatic, degenerative, inflammatory or neoplastic in nature. Atlanto-axial dislocation and basilar invagination may be seen in both congenital and acquired conditions. Symptoms may refer to the cervical spinal cord, brainstem, cerebellum, cervical nerve roots, lower cranial nerves, and the vascular supply to these structures or the adjacent cerebrospinal fluid channels. Craniocervical junction abnormalities are congenital or acquired abnormalities of the occipital bone, foramen magnum, or first two cervical vertebrae that decrease the space for the lower brain stem and cervical cord [3]. Suspect a craniovertebral junction abnormality if patients have persistentpain in the neck or occiput plus neurologic deficits and symptoms related to the lower brain stem, upper cervical spinal cord or cerebellum. Diagnose craniovertebral abnormalities using MRI or CT of the brain and upper spinal cord. Treatment based on the clinical condition and most of the patients are treated with reduction andimmobilization of compressed neural structures few needs surgery [4].

Materials and Methods

The descriptive study was carried out in the Department of Anatomy, Meenakshi Medical College & Research Institute in collaboration with Department of Radiology (2016-2017), after the institutional ethical committee clearance. The duration of study was one year. Reformatted midline sagittal plain CT images of 150 patients (M-68, F-82) were retrospectively evaluatedin this study. More than 20 years of age with the presentation of specific symptoms were included in this study. The shortest perpendicular distance was measured from the Chamberlain's and McRae's baselines for each subject to the odontoid tip. McRae line is a line drawn on a lateral radiograph of skull connecting the basion and opisthion of the foramen magnum. The tip of the dens should be below the line. Chamberlain line is drawn from the posterior pole of the hard palate to the tip of the opisthion. The tip of the odontoid process should be below the line and not more than 5 mm above it.

CT Position and Analysis

Patients were positioned supine with the orbitalmeatal line perpendicular to the horizontal axis of the table. The head was placed in a cephalstat and secured with forehead band to minimise motion and rotational movements. Three to four millimeters slice thickness noncontrast axial scans of the skull base and upper part of the cervical vertebrae were obtained. Appropriate collimation was done to reduce radiation dose. Measurements were made in accordance with the standard skull-base line definition. The skull-base line points (posterior end of the hard palate, anterior and posterior margin of the foramen magnum) were easily and accurately identified on bone windows CT. The shortest perpendicular distance from each skull-base line to the tip of the odontoid process was measured.

Exclusion Criteria

Head injuries, Klippel-Feil syndrome, odontoid anomalies, or hypoplasia of the atlas, acquired deformity of the skull suggestive of basilar impression development, such as Paget's disease, osteomalacia, rickets, osteogenesis imperfecta, rheumatoid arthritis, neurofibromatosis, and ankylosing spondylitis and a brain tumor or metastatic lesion were excluded from the study.

Statistical Analysis

Results will be expressed as mean±standard deviation and range. Unpaired' test will be used to compare between male and female in CT images. A p-value of 0.05 or less than will be considered for clinical significance.

Results

Out of 150 patients males were (n=68) representing 45.53%. The rest were females (n=82) representing 54.67% of the sample. The age ranged between 21 and 80 years. The mean age of the study patients was 45.5±5.5years; themedian was 50.5 years. In male majority of the patients were in the 41-50 age group (n=23, 33.8%) followed by the 51-60 age group (n= 13, 19.1%). In female majority of the patients were in the 31-40 age group (n=32, 39.02%) followed by the 41-50 age group (n= 20, 24.39%). Female patients

were relatively younger compared to the male patients in all the age groups. Simple head trauma and chronic headache were the most common clinical presentation for CT. The mean position of the odontoid process was 2.65 mm below Chamberlain's line (median 2.7 mm, SD 0.21mm) and 4.6 mm (median 4.6 mm, SD 0.19 mm) below McRae's line. There was no statistically significant difference in measurements between male and female patients.

The parameters of both Chamberlain and McRae lines of our study is very close to the Suzgo study and McRae lines is close to CG Cronin study.

Table 1: This table shows our study and compared with the previous studies

SUZGO		CG Cronin		Our Study Outcome	
Position of the odontoid process below the Chamberlain line in mm Mean - 2.6 Median - 2.7	Position of the odontoid process below the McRae line in mm Mean - 4.6 Median -4.7	Position of the odontoid process below the Chamberlain line in mm Mean – 1.4 Median – 1.2	Position of the odontoid process below the McRae line in mm Mean - 5 Median -5	Position of the odontoid process below the Chamberlain line in mm Mean – 2.65 Median - 2.7 8 cases (M-5,F-3) above the line not more than 4.9 mm	Position of the odontoid process below the McRae line in mm Mean– 4.6 Median – 4.6 No cases above the line

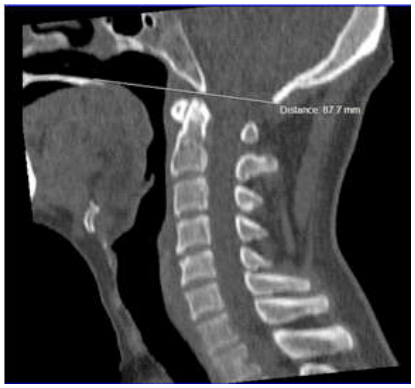

Fig. 1: Shows the measurement of chamberlain's line

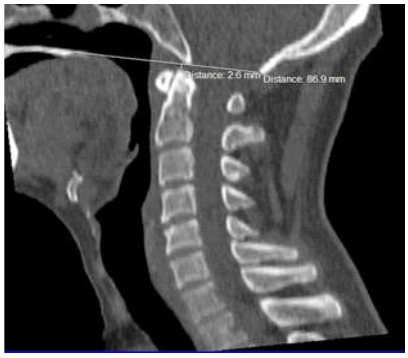

Fig. 2: Shows the tip of the odontoid process below the chamberlain's line.

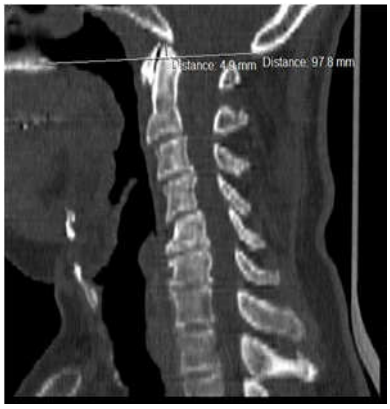

Fig. 3: Shows the tip of the odontoid process above the chamberlain's line.

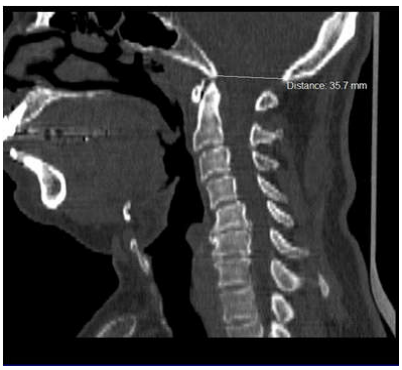

Fig. 4: Shows the measurement of mcrae's line

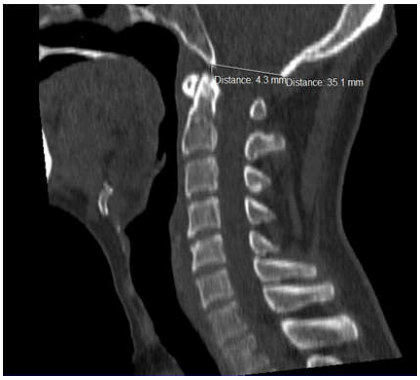

Fig. 5: Shows the tip of the odontoid process below the mcrae's line

Discussion

The development of odontoid is complex. The top of the dens develops from the proatlas which is cranial half of the first cervical sclerotome. The rest of the dens develops from the caudal half of the first cervical

sclerotome. Body and neural arches of the axis develop from the second cervical sclerotome [5]. Proatlas also forms the anterior margin of theforamen magnum, occipital condyles and thethird condyle of the occipital bone similarly caudal portion of the first cervical sclerotome also forms lateral masses and posterior arch of theatlas. Therefore, odontoid dysgenesis is frequently associated with anomalies of basiocciput and atlas [6]. The cruciate and alar ligaments are condensation of the lateral portion of proatlas. A secondary ossification centre appears at the apex (the terminal ossicle) at 3-6 years of age and fuses with the rest of the dens by 12 years of age. Posteriorly, the neural arches fuse by 2-3 years of age. In a young child, the unossified portions of the odontoid may give the false impression of odontoid hypoplasia [7]. Similarly, one may erroneously conclude that the child has C1-2 instability, because the anterior arch of the atlas commonly may slide upward and protrude beyond the ossified portion of the odontoid on the lateral extension radiograph [8]. Evaluating variations between sexes, the findings from this descriptive study and associated literature review provided some useful insights regarding the differences in the relationship of the odontoid tip and skull baselines [9]. The study findings revealed that in males the mean distance from the odontoid tip to Chamberlain's line was 2.54 millimeters (SD 0.19millimeters) and McRae's 4.34 millimeters (SD .17 millimeters).

In female patients, the mean distance from the odontoid tip to Chamberlain's line was 2.76 millimeters (SD 0.23millimeters) and McRae's line was 4.86 millimeters (SD 0.21 millimeters).Using student's t-test there was no significant difference in the distances demonstrated between the two sexes [10]. There were cases in both sexes where the tip of the odontoid was above the lines of Chamberlain's but with no clinical symptoms. This was mostly observed in elderly patients [11]. The maximum asymptomatic distance at which the tip of the odontoid process was above the Chamberlain's was 4.9 millimeters in males and 3.2 millimeters in females. The odontoid tip was never above the McRae's line [12]. CT bone window the clear separation of bone from adjacent soft tissues and the capabilities to easily obtain a midsagittal reconstructed image resulted in more accurate measurements [13]. The findings of the study demonstrated that there was a decrease in the distance from the tip of the odontoid process to skull baselines of Chamberlain's and McRae's with advancing age and in some cases the odontoid tip was above the skull baselines with no clinical symptoms. [14,15]. A possible explanation for these findings is that with age, bone and adjacent soft tissue undergo involution. Bone demineralization (osteomalacia) due to age predisposes to bone deformities. Associated ligament laxity may lead to joint subluxation resulting in theupward migration of the odontoid tip [15,16]. Though there was a notable difference in the distance from the odontoid tip to skull baselines with age in our current study, statistical correlation of the findings demonstrated no significant difference (p-value < 0.05)[17].

Conclusion

The Odontoid process is affected by a variety of congenital and acquired diseases. Imaging of this small structure to reach a specific diagnosis continues to be a challenge for radiologists. Multiplanar imaging with CT allows more detailed evaluation of bony and soft tissue structures. Adequate knowledge of development, complex anatomy, various disease processes, topographic relationships of odontoid with respect to CVJ and craniometry in association with theappropriate clinical background can provide ameaningful diagnosis. The distances of the odontoid tip to the skull baselines of Chamberlain's and McRae's were noted to be higher in males than females. The difference seen was however not statistically significant. The study revealed that the distance of the odontoid tip to standard skull baselines was reducing with age. Resorbtive bone changes of the elderly and laxity of ligaments supporting the odontoid process were possible explanations. Bony landmarks were clearly identified and the measuring techniques were easily demonstrated in this study using multiplanar CT. These results provide the mean of normal distance from the odontoid process to the standard skull base lines on CT. This study can be used as a base line data to access skull base problems.

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Conflict of Interest: None

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Original Article

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Attitude towards Dissection among First Year Students in a Medical College in Mandya

Asharani S.K.[1], Shashikantha S.K.[2]

Abstract

Background: Dissection has been used for centuries to explore anatomy. Objections to the use of cadavers have led to the use of alternatives including virtual dissection of computer models. The current state of dissection in Anatomy is deteriorating. The number of hours spent by the students in dissection labs during medical school has decreased substantially over the last few years. The future of anatomy will be probably an elegant mix of traditional method and computer learning. *Aim:* To study the attitude of first year medical students towards dissection. *Materials and Method*: A cross sectional questionnaire based study was conducted in the department of Anatomy, Adichunchanagiri Institute of medical sciences, BG Nagara on 150 first year medical students. The data obtained was analyzed statistically. *Results:* Most of the students believed that dissection is an important tool and it facilitates anatomy learning. According to them it improves the skill but at the same time it consumes a lot of time. *Conclusion:* The use of dissection in medical training has been shown more effective in the retention of intended information than their simulated counterparts. The combinations of these methods are intended to strengthen the students understanding of anatomy, a subject that is infamously difficult to master.

Keywords: Attitude; Dissection; First Year Students.

Introduction

During the prehistoric period, there was very little scope to study human anatomy by dissections due to superstitious beliefs, religious impositions and faith in supernatural power. People gathered knowledge of anatomy from experiments on sacrificed animals. The urge for learning human anatomy grew to such an extent that some over-inquisitive men resorted to stealing dead body from the graveyardfor the said purpose. Thus, the purposeful anatomy emerged from the myths and mythology into a definitive science [1].

Cadaver dissection has been used as the main method of teaching human anatomy for the last five centuries. There are emerging concerns on the negative consequences of cadaver dissection on medical students, leading to suggestions on use of alternative technological advancements to cadaver dissection [2].

The teaching of Anatomy in medical schools has traditionally been based around the use of human cadaveric specimens, either as whole body specimens for dissection or as already prosected specimens for study by students. In medical schools where cadaveric dissection is still included in preclinical teaching and instruction in anatomy, students are exposed to cadavers in the early stages of their training. This exposure induces positive and unintended negative experiences in these students. The impact of such exposure on students has been examined in some studies to evaluate its emotional impact and the ability of students to cope [3].

Many studies have been conducted to determine the emotional reactions of medical students to the dissection room [4].

Working with cadavers constitutes a potential stress which induces both positive and negative experiences in these students. The exposure has both the physical (smell, nausea, conjunctival irritation) and psychological (anxiety, stress, emotional trauma, depression) impact on students [5].

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Thus this study was undertaken among first year medical students to know their positive and negative attitude towards dissection.

Materials and Methods

The study was done among first year medical students of Adichunchanagiri Institute of Medical Sciences, BG Nagara, Mandya district. A total of 150 students were included in the study. The full strength participation of the subjects was ensured. The study questionnairewhich included information regarding their attitude towards dissection in their first year of the course was administered to students after obtaining their written consent. The ethics committee approval was taken prior to commencement of the study.

The study was of cross sectional type which included details of the subjects collected at one point of time in the study period. The information obtained was coded and entered in a excel sheet and analyzed. The suitable percentage and proportions were calculated in interpretation of the result obtained.

Results

Almost all the students (98%) stressed the need of dissection in their learning of medicine. Nearly 50% of the students had some fear about handling the cadaver. About 10% of the subjects were not so happy in handling the cadaver. More than 70% of the subjects were excited about dissection and the knowledge they gain from that.

Nearly 40% of the subjects presented with one or the other symptoms of illhealth like headache, nausea, giddiness and unable to bear the smell because of dissection procedure. According to 68% of the subjects dissection should not be replaced by newer methods of teaching like models & computers. Ninety six percentage of the subjects feel that dissection will enhances their surgery skills.

- The difference in the response of the students towards time consumption is not too variable. Forty eight percent say yes, 42% no and 11% neutral.
- The study also compared dissection to the use of prosected specimens. The results were slightly in favour of dissection.

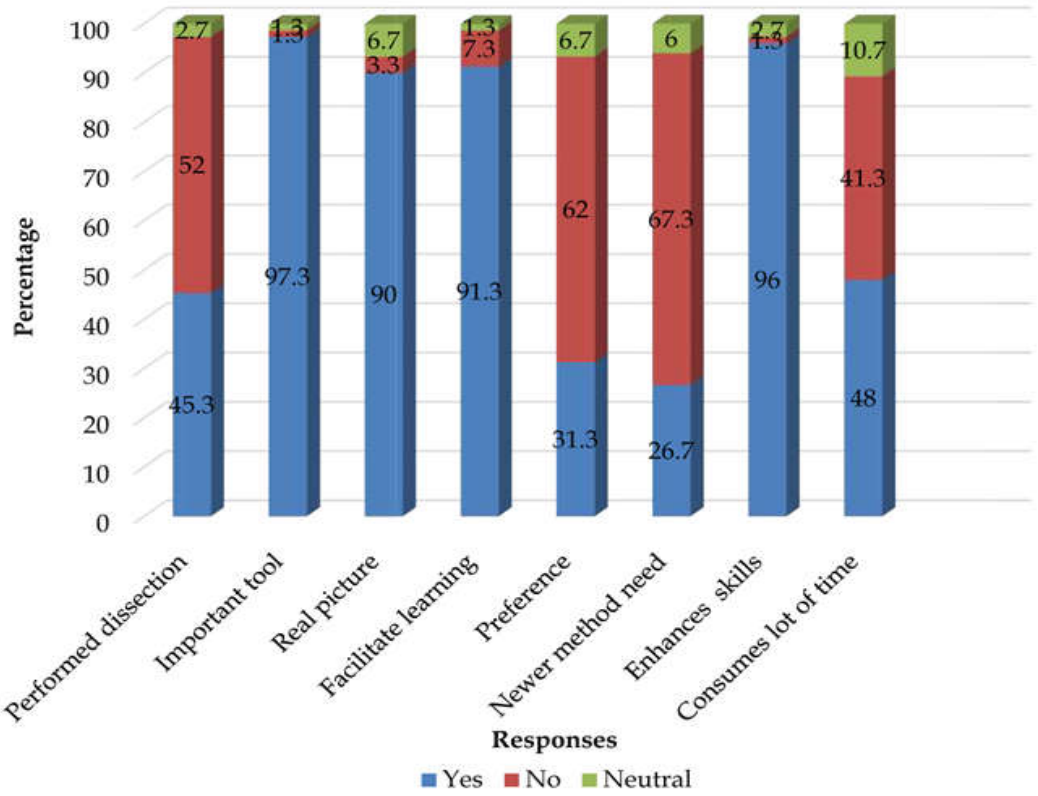

Fig. 1: Student response towards dissection

Discussion

The dissection remains the most powerful means of presenting and learning anatomy. Dissection reinforces and elaborates knoweldge that is acquired in lectures and tutorials [6]. Learning anatomy by dissection provided students with a clearer understanding of how to connect concepts.

The main disadvantages as perceived by students of the current study are the 'time consuming nature of dissection,' 'difficulty in finding correct structures', and the 'smell of the embalmed cadavers.' By nature of its attributes, dissection is time consuming compared to other forms of learning anatomy; however, this slow but sequential nature of dissections may be beneficial to study and understand complex anatomical regions such as limbs which can be challenging for a beginner due to the content, complexity and the terminology involved.

Considering the significant time limitations and strong emphasis placed on clinical applicability of basic sciences such as anatomy from the outset of modern medical curricula, it is important to identify the specific components that can be delivered using dissection which facilitates engagement of students in an active learning experience [7].

In a study done by Karau PB et al, majority of the students found their first visit to the dissection room exciting (85.3%). A third of the respondents (30.7%) felt emotional shock at initial exposure to the cadaver, but the shock wore off gradually in 87% of them. There was an overwhelming favorable attitude towards human anatomy, with most students agreeing that dissection should not be replaced by computer models (72%), gives better results than prosected specimens (96%) and is indispensable for learning. Most of them considered dissection the best method of learning anatomy [2].

Few studies recorded student attitudes as they progressed through dissection classes and compared it with baseline attitudes after repeated exposure. In their study anxiety of the students had decreased while interest had increased on subsequent exposure to dissection [8].

The study done by Wyk VJ and Rennie CO reported a positive experience (70%) during anatomical dissection in terms of visual and clinical application. Students further indicated that learning through the dissection provided them with a foundation which would be useful as future doctors. This aspect is especially important in a medical curriculum and further supports the philosophy of problem-based learning where a deeper understanding of the basic sciences is essential in relating scientific concepts to practical clinical examples which is important in developing their cognitive skills [9].

Apart from teaching, cadaveric workshops are useful adjuncts when teaching operative skills. In particular, there is little research into how these workshops improve the performance of surgical trainees during subsequent live surgery. However, both trainees and assessors hold them in high regard and feel they help to improve operative skills. Further research into the role of cadaveric workshops is required [10]. Anatomical dissection being an active, student-centred and exploratory way of learning can be considered harmonious with current trends in medical education [7].

Conclusion

The use of dissection in medical training has been shown more effective in the retention of intended information than their simulated counterparts. The combinations of these methods are intended to strengthen the students understanding of anatomy, a subject that is infamously difficult to master. Computer and multimedia should be complementary but not a substitute to dissection.

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Original Article

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Supracondylar Humeral Process: An Osteological Study and its Clinical Implications

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Abstract

Introduction: In humans, a hook-like bony process called Supracondylar process is occasionally seen on the anteromedial surface of the humerus. It has also been referred as the supraepitrochlear, supracondyloid, epicondyloid, or supratrochlear spur. It is curved, directed downwards and forwards, and its pointed apex is sometimes connected to the medial border just above the medial epicondyle by fibrous band known as Struthers ligament. Supracondylar process represents the embryologic vestigial remnant of climbing animals and seen in many reptiles, most marsupials, cats, lemurs and American monkeys. *Aim:* To study the incidence of supracondylar process of humerus. *Materials and Methods:* 88 adult dry humeri were collected from the Department of Anatomy, Subbaiah Institute of Medical Sciences and were examined for any osseous projection from the distal part. *Results:* Out of 88 humeri, we found one humerus of left side with a bony projection from anteromedial surface of its distal shaft. The bone was then examined, studied, photographed and its dimensions were recorded using Vernier calipers. *Conclusion:* Knowledge of this variation is of great importance to anatomists and anthropologists because of the possible link to the origin and relation of human races and also to radiologists, orthopaedicians and surgeons due to its clinical implications.

Keywords: Supracondylar Process; Humerus; Struther's Ligament.

Introduction

Supracondylar process is a hook-like bony process which varies from 2 to 20 mm in length. It occasionally projects from the anteromedial surface of the shaft of the humerus, about 5 cm proximal to the medial epicondyle. It has also been referred as the supraepitrochlear, supracondyloid, epicondyloid, or supratrochlear spur. It is curved, directed downwards and forwards, and its pointed apex is sometimes connected to the medial border just above the medial epicondyle by fibrous band to which part of pronator teres is attached [1]. This fibrous band, known as ligament of Struthers, represents the lower head or third head of coracobrachialis. At times it maybe ossified [2].

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The supracondylar process of the humerus has been described by anatomists and anthropologists and is phylogenetically considered to be a remnant of the supracondylar foramen found in reptiles, marsupials, and some mammals [3,4]. The Supracondylar process of humerus has been mentioned in 16th century by Coiter as cited by Marquis et al. [5]. It was first noted in apes and monkeys by Tiedemann in 1822 who described it as pathological exostosis and later in human by Knox [6,7]. Supracondylar spur or process was first described by Struther in 1849 [8]. According to Kessel and Rang, the ligament actually represents lower part of tendon of a vestigial muscle latissimus condyloidieus, which is found in climbing animals and extends from latissimus dorsi to the medial epicondyle. It serves as an anchor for the pronator teres muscle. In the lower mammals, the osteo-fibrous tunnel formed by the humerus, the supracondylar process and Struthers' ligament protects the neurovascular bundle that extend to the forearm [9]. Its occurrence in humans is very rare, the reported incidence of SCP varies from 0.1% to 2.7% in different races [10].

Struthers' ligament passes over the median nerve and the brachial artery, and can cause compression

of these structures. The clinical symptoms associated with Supracondylar process are median nerve entrapment with or without brachial artery compression, ulnar nerve entrapment, and fracture of the process. The symptoms are exacerbated by pronation of forearm or by extension and pronation/supination of forearm. Nerve compression usually causes intense pain, paresthesia, sensory loss, and muscular weakness in the area of median nerve. In rare cases of localized brachial artery compression due to Supracondylar process, ischemic symptoms such as claudication and coldness, and reduced radial and ulnar pulses can be detected [11].

Hence knowledge of this variation is of great importance to anatomists and anthropologists because of the possible link to the origin and relation of human races and also to radiologists, orthopaedicians and surgeons due to its clinical implications.

Materials and Methods

Eighty eight adult dry humeri were collected from the Department of Anatomy, Subbaiah Institute of Medical Sciences and were examined for any osseous projection from the distal part.

Observations and Results

The Supracondylar process was projecting from distal one-third of shaft of humerus on anteromedial surface and was directed downwards, forwards, and medially. Dimensions of projection were recorded with vernier calipers and photographs were taken [Figure 1]. The following observations were recorded:

1. Length of Supracondylar process was 0.9 cm
2. Breadth at the base was 1.2 cm
3. It was located at 5.5 mm distance from medial epicondyle
4. It was at a distance of 4.8 mm from the nutrient foramen

The results were compared with other similar studies and are tabulated in Table 1. The incidence of supracondylar process was also compared with other races as shown in Table 2.

Fig. 1: Left humerus showing supracondylar process

Table 1: Comparison of the parameters of Supracondylar process with other studies

Study	No of humerus	Length of supracondylar spur in cm	Breadth of supracondylar spur in cm	Distance of the spur from the medial epicondyle in cm	Distance of the spur from the nutrient foramen in cm
Gupta et al [10]	380	0.3	1.1	6.5	-
Vandana R [11]	133	8	1.2	5.3	3.8
Dinesh K Patil et al [13]	60	0.91	-	5.43	-
Struther [18]		1.2 to 1.9	-	3.2 to 6.4	-
Shivleela et al [19]	-	1	-	6	-
Nag et al [20]	-	2.4	-	5.6	-
Prabhahita [21]	80	1.1	1.5	4.4	6.5
Present study	88	0.9	1.2	5.5.	4.5

Table 2: Incidence of supracondylar process in different races

Author	Incidence (%)	Population/race
Gruber (1865)	2.7	European race
Danforth (1924)	0.5	Mixed
Adachi (1928)	0.8	Mixed
Terry (1930)	1.16	European race
Terry (1930)	0.1	Negros
Hrdlicka (1923)	1	American Indians
Dellon (1986)	1.15	European race
Parkinson (1954)	0.4	Mixed
Natsis (2008)	1.3	Caucasians
Gupta et al (2008)	0.26	Indian
Prabhahita (2012)	1.24	Indian
Vandana R (2014)	0.76	South Indian population
Alka et al (2016)	0.78	Indian
Present study	1.25	Indian

Discussion

Skeletal data has been a central focus for race estimation in anthropology [1]. Morphological differences help to find the missing links between the different stages of evolution. The knowledge of variations is not only important to anatomists and anthropologists but also to radiologists, anesthetists and surgeons. One such variation is the "supracondylar" process.

The incidence of the supracondylar process of the humerus is very low and the percentage of incidence varies in different. According to Danforth, differences in racial incidence of particular variation are probably due to differential distribution of genes with reference to race. He also proposed the idea of somatic mutation as a general cause these small variations, at least in human material [12].

In our study, the incidence was 1.25% which was almost similar to previous studies. But the study on 60 dry humeri on Indian population by Dinesh K et al., showed incidence of about 8.3% [13]. The various parameters measured were also compared with different authors and were found to be almost similar.

The supracondylar process if present, is usually clinically silent, but can become symptomatic by presenting as a mass or may be associated with symptoms of median nerve compression and claudication of the brachial artery [14]. Ligament of Struthers, a fibrous band maybe present which extends from the supracondylar process to the medial epicondyle [1]. From embryological point of view, the Struthers ligament lies between the tendon of the latissimus dorsi and the coracobrachialis and corresponds to the lower part of the tendon of the vestigial latissimo-condyloideus, a muscle found in climbing mammals which extends from the tendon of insertion of the latissimus dorsi muscle to the medial epicondyle [9]. Rarely, this fibrous band may ossify forming a supracondylar foramen, a tunnel which transmits the median nerve and the brachial artery and sometimes a variant ulnar artery or the ulnar nerve [15,16].

In patients of pain and sensory disturbance of forearm and hand, knowledge about supracondylar spur should be used while diagnosing with radiological imaging procedures [17]. This variation should also be considered while doing venesection at the elbow.

Conclusion

Presence of supracondylar tubercle has an evolutionary significance. The supracondylar process is frequently misjudged as a pathological condition of the bone rather than as a normal anatomical variation. Though it is a very rare vestigial structure in humans, yet it is known to have racial variations.

Clinical symptoms may be associated with Supracondylar process like median nerve entrapment with or without brachial artery compression, ulnar nerve entrapment, and fracture of the process. Since it may not be palpable due to muscles covering it, radiographic investigations are suggested in cases with symptoms of median neuropathy. So the knowledge of the supracondylar process is equally important for clinicians so that it may not be overlooked and there may be misdiagnosis.

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International Journal of Practical Nursing	Triannual	5500	5000	430	391
International Physiology	Triannual	7500	7000	586	547
Journal of Animal Feed Science and Technology	Semiannual	78500	78000	6133	6094
Journal of Cardiovascular Medicine and Surgery	Quarterly	10000	9500	781	742
Journal of Forensic Chemistry and Toxicology	Semiannual	9500	9000	742	703
Journal of Geriatric Nursing	Semiannual	5500	5000	430	391
Journal of Global Public Health	Semiannual				
Journal of Microbiology and Related Research	Semiannual	8500	8000	664	625
Journal of Nurse Midwifery and Maternal Health	Triannual	5500	5000	430	391
Journal of Organ Transplantation	Semiannual	26400	25900	2063	2023
Journal of Orthopaedic Education	Triannual	5500	5000	430	391
Journal of Pharmaceutical and Medicinal Chemistry	Semiannual	16500	16000	1289	1250
Journal of Practical Biochemistry and Biophysics	Semiannual	7000	6500	547	508
Journal of Psychiatric Nursing	Triannual	5500	5000	430	391
Journal of Social Welfare and Management	Triannual	7500	7000	586	547
New Indian Journal of Surgery	Bi-monthly	8000	7500	625	586
Ophthalmology and Allied Sciences	Triannual	6000	5500	469	430
Otolaryngology International	Semiannual	5500	5000	430	391
Pediatric Education and Research	Triannual	7500	7000	586	547
Physiotherapy and Occupational Therapy Journal	Quarterly	9000	8500	703	664
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Study of Various Sacral Indices in Sexual Dimorphism in the Region of Gujarat

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Abstract

Context: Sacrum shows sexual diamorphism and hence functionally influences the pelvis. Sexual diamorphism is also influenced by the interaction between the environmental and genetic factors. Based on various sacral indices gender discrimination of the skeletal material can be done to establish the identity of the individual. *Aims:* To study various sacral indices in sexual dimorphism in the region of Gujarat and compare it with other studies. *Settings and Design*: Various sacral dimensions of dry scara were measured with the help of vernier calliper and flexible tape. Various sacral indices were calculated and statistically analysed. *Methods and Material*: The study was conducted on 110 adult sacra dry bone of known sex (62male and 48 female) obtained from the department Anatomy, GMC Surat, SMIMER and BJMC Ahmadabad. *Statistical analysis used*: The observations were tabulated for quantitative variable (Mean+/- 3SD). Two independent sample t test was applied to check group mean differences. The minimum in male range (A to B) and maximum in female range (C to D) were chosen as demarking points respectively for females and males. *Results:* In the present study the P value of various sacral indices was found to be less than 0.005 and thus highly significant. *Conclusions*: Based on various sacral indices and demarking points the sexual diamorphism of sacrum can be established with increased accuracy. The metric parameters are significantly different for different population groups.

Keywords: Sacral Indices; Demarking Points; Male; Female; Sexual Dimorphism.

Introduction

The Sacrum is a large, triangular bone formed by the fusion of the five sacral vertebra. In an articulated pelvis, it forms the posterior boundary of the pelvic cavity. It is wedge shaped and it is placed obliquely in between two hip bones.

It articulates above with the fifth lumber vertebra at the lumbosacral angle and at the caudal end it articulates with the coccyx. It forms the caudal portion of axial skeleton and also contributes to the formation of pelvic girdle. Its morphology and morphometry influences the functional differences in the pelvic region between the two sexes. It has been customary among anatomists, anthropologists, and forensic experts to identify sex of skeletal material by metric and non metric observations. Sacrum is an important bone for this purpose, both as an Individual bone and as a part of pelvis.

The purpose of the present study is to measure various sacral indices and its significance in sexual diamorphism in the population of Gujarat and compare it with other studies.

Subjects and Methods

The study was conducted on 110 adult sacra dry bone of known sex (62male and 48female) obtained from the department Anatomy, GMC Surat, SMIMER and BJMC Ahmadabad. Following measurements as shown in (Figure 1,2,3,4,5) were taken with the help of digital vernier calliper, & flexible tape.

By using these measurements various sacral indices were calculated as follows–

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1. Sacral index
   = Width of the sacrum x 100
   Straight length of sacrum

2. Curved index
   = Straight length of sacrum x 100
   Mid ventral curved length of sacrum

3. Index of the body of 1st sacral vertebra
   = A-P diameter of the body of the 1st sacral vertebra x 100
   Transverse diameter of the body of 1st sacral vertebra

4. Corporo-basal index
   = Transverse diameter of body of 1st sacral vertebra x 100
   Width of sacrum
5. Auricular index
   = Length of auricular surface x 100
   Width of the sacrum

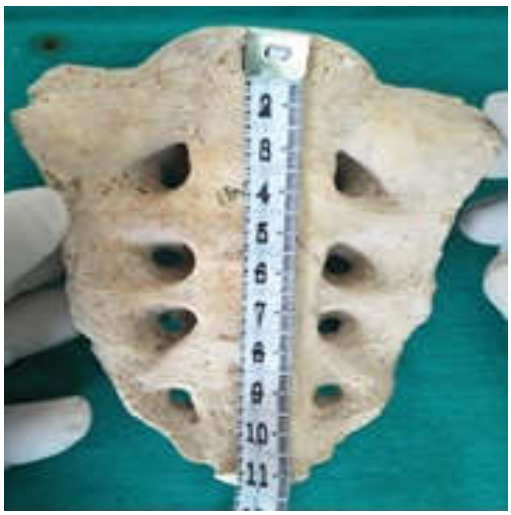

Fig. 1: Curved length of ventral surface of sacrum

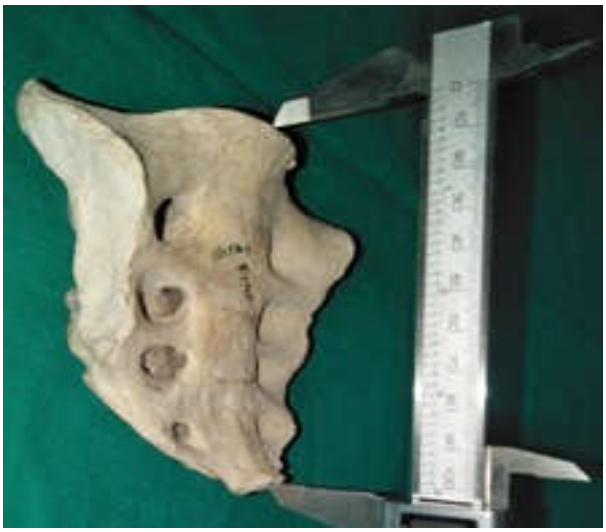

Fig. 2: Straight length of sacrum

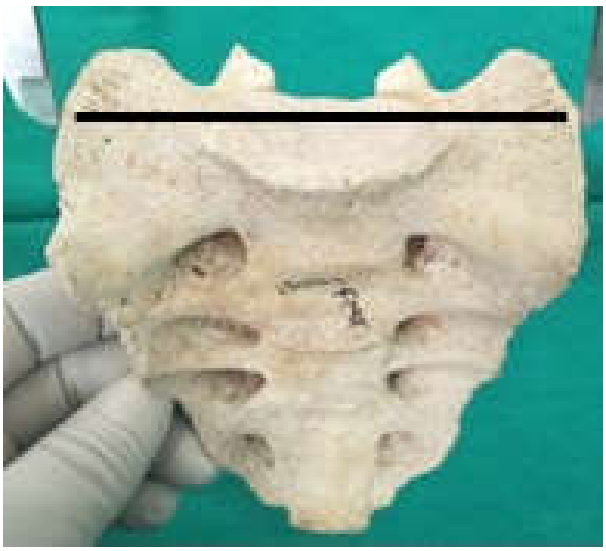

Fig. 3: Width of base of sacrum

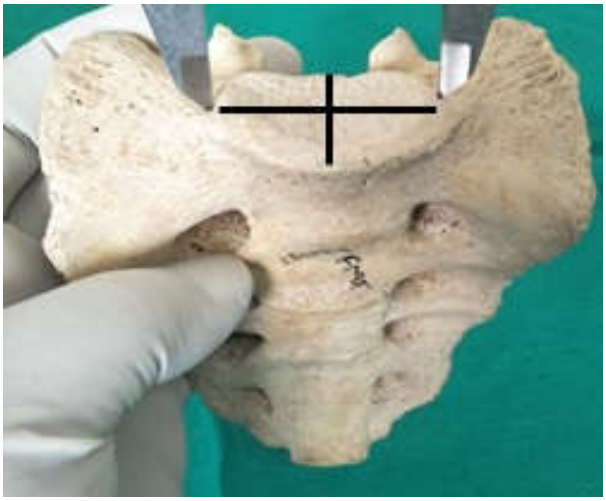

Fig. 4: Transverse and AP diameter of body of S1 vertebra

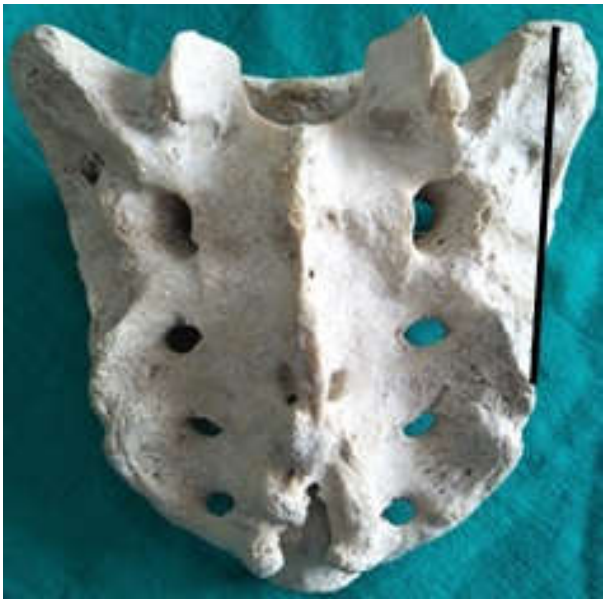

Fig. 5: Length of auricular surface of sacrum

The observations were tabulated for quantitative variable (Mean+/- 3SD). Two independent sample t test was applied to check group mean differences. The minimum in male range (A to B) and maximum in female range (C to D) were chosen as demarking points respectively for females and males. Sacrum with measurement less than A were considered as female sacra and greater than D were considered as male sacra according to curvature index and corporobasal index. Sacra with measurement less than C were identified as male sacra and greater than D were identified as female sacra according to sacral index, Index of body of S1 and auricular index. In all indices measurements p-value of < 0.05 was considered as statistically significant parameter for sex determination of sacra.

Results

As depicted from table 1 the p value of all the sacral indices i.e sacral index, curvature index, corporobasal index, Index of body of first sacral vertebra and auricular index is < 0.05 that means statistically highly significant. The percentage of bone identified by demarking points (DP) is maximum with sacral index i.e 17.74% in males and 42.86% in females. Identification by demarking points of auricular index appears to be maximum in male sacra i.e 24.19%. Sex determination by considering demarking points of all other indices is less effective. Gender discrimination in very few sacra is possible by using demarking points for each sacral index as depicted in table 1 due to overlapping values. If demarking points is calculated by considering all the sacral indices then gender detection of almost 92% of the sacra can be done.

Discussion

Sacrum is a very important bone to determine the sex of skeleton. Interaction between the environmental and genetic factors influence the development of bones. While teaching sex difference in bones much stress is laid on the importance of sacrum. There is paucity of available data to test the validity of the number of parameters described to identify the sex of sacrum [15]. As seen from Table 1 the P value of all sacral indices i.e Sacral index, Curvature Index, Corporobasal index, auricular index and index of body of first sacral vertebra is less than 0.05 suggesting that all these sacral indices are highly significant. These findings concur with those of U U joshi et al. [2], Raju P.B et al. [3], Davivongs [1] and Renuka [4]. If only sacral index is used 53.33% of male sacra and 46.67% of female sacra can be accurately identified [5]. If all indices are considered accuracy of sex determination is further increased.

In the present study and studies done by other authors (Table 2a,2b,2c,2d) all the dimensions i.e mean length, mean width, mean curve length, mean transverse diameter of body of S1, mean auricular length, are more in males as compared to females except the mean AP diameter of S1 vertebra. The mean AP diameter of S1 vertebra is significantly higher in females as compared to males in the present study. The mean AP diameter of Female S1 vertebra is also significantly higher when compared with other studies.

As seen from Table 2b all the sacral indices are higher in males as compare to females except the index of body of S1 vertebra which is the other way round in all population groups. However, Snell [6] has reported the index of body of S1 vertebra to be lower in females than males. According to Snell [6] and Frazer [7] the female sacrum is broad and curves sharply at the lower end, while in males it is more or less uniformly curved. This is due to the functional differences of the male and female pelvis.

In the present study (Table 2c) the mean sacral index in males is 97.66mm which categorises it into dolicoheric type. These findings are similar to the studies done by Mishra et al. [8] and Patel et al. [9].

Table 1: Observations

Sr. No.	Parameters	Sex	Range	Mean	SD	T Value	P value	Calculated Range: Mean+/- 3SD	DP	% of Bone Identified By DP
1	Length of sacrum	M	90-125	104.55	7.53	6.63	<0.0001	81.96-127.14	>118.53	
		F	80-113	94.66	7.89			70.79-118.53	<81.96	
2	Width of sacrum	M	85-117	101.53	5.80	3.56	<0.001	84.13-118.93	<86.98	0
		F	94-117	105.67	6.23			86.98-124.36	>118.98	0
3	Curve length of sacrum	M	96-138	112.03	8.49	4.76	<0.0001	86.56-137.50	>131.07	3.22
		F	88-125	103.98	9.03			76.89-131.07	<86.56	0
4	Transverse Diameter of body of 1st sacral vertebra	M	40-58	46.53	4.27	1.81	>0.05	33.72-59.34	>56.11	0
		F	35-52	30.85	2.70			35.35-56.11	<33.72	0
5	Antero-posterior diameter of 1st sacral vertebra	M	24-36	29.89	2.80	1.10	>0.05	21.49-38.29	<22.75	0
		F	25-36	45.73	3.46			22.75-38.95	>38.95	0
6	Length of auricular surface	M	50-66	56.08	4.13	1.63	>0.05	43.69-68.47	>67.25	0
		F	46-60	54.77	4.16			42.29-67.25	<43.69	0
7	Sacral index	M	89.90-108	97.66	5.29	12.68	<0.0001	81.79-113.53	<92.08	17.74
		F	101.85-130.95	112.12	6.68			92.08-132.16	>113.53	42.86
8	Curvature index	M	89.23-98.14	93.28	2.37	3.04	<0.01	86.17-100.39	<78.55	0
		F	83.16-97.97	91.21	4.22			78.55-103.87	>100.39	0
9	Corporobasal index	M	40-53.06	45.85	3.39	3.82	<0.001	35.66-56	>52.82	1.61
		F	34.86-50	43.46	3.12			34.10-52.82	<35.66	2.08
10	Index of the body of 1st sacral vertebra	M	56-72.91	64.38	4.35	3.54	<0.001	44.89-65.59	<38.67	0
		F	56-76.91	67.68	5.20			38.67-65.67	>65.59	0
11	Auricular index	M	47.23-61.32	55.24	3.45	3.94	<0.001	55.33-77.43	<52.08	24.19
		F	42.10-60.60	52.17	4.50			52.08-83.28	>77.43	0

Table 2a: Comparison of mean of length, width and curve length of present study with other studies

Sr. No.		Mean length (mm)	Mean width (mm)	Mean Curve length (mm)
1	Present Study in Gujrat	Male –104.55 Female – 94.66	Male – 101.53 Female – 105.67	Male – 112.03 Female – 103.98
2	A K Arora et al (2010)[20] study in Punjab	Male – 109.74 Female – 91.22	Male – 101.94 Female – 114.22	
3	Anil Kumar et al [19](2013)	Male – 102.7 Female – 93.5	Male – 99.9 Female -109.5	Male – 116.4 Female – 110.7
4	Shailendra Patel et al [18] (2014) Study in Madhya Pradesh	Male – 109.47 Female – 94.46		
5	Arpan Dubey et al[5](2016)	Male – 113.5 Female -94.6	Male – 105.83 Female – 104.33	
6	Shweta Asthana et al[17] (2014)	Male – 106.96 Female – 90.52	Male – 103.07 Female – 102.67	
7	Maddikunta V et al[16] (2014) Study in Telangana	Male – 113.9 Female - 90	Male – 104.2 Female – 103.4	Male – 125 Female - 100
8	Kataria et al [14] (2014) study in Rajasthan	Male – 106.7 Female – 91.91	Male – 110.3 Female – 109.88	
9	William F Manish[15] (2017) (Rajasthan)	Male – 107.44 Female – 91.65	Male – 104.63 Female – 102.77	
10	Mishra et al[8] (2003)	Male – 107 Female – 90.58	Male – 105.34 Female – 105.79	Male – 119.56 Female – 100.95
11	Raju and Singh[3] et al (1981)	Male – 104.96 Female -92.72	Male – 103 Female -105.33	Male – 112.75 Female -104.81
12	Flander et al [11] (1978)	White Americans Male – 110.20 Female – 109.64 Black Americans Male – 105.50 Female – 99.98	White Americans Male – 116.42 Female – 117.62 Black Americans Male – 111.14 Female – 111.36	White Americans Male – 128.36 Female – 124.72 Black Americans Male – 120.6 Female – 111.72
13	Stradalova et al[12] (1974)	Male – 101 Female -98.47	Male – 117.25 Female -114.94	Male – 115.86 Female -112.15
14	Davivongs et al[1] (1963) (Study on African Aborigines)	Male – 96.52 Female – 88.12	Male – 99.92 Female – 101.24	Male – 104.34 Female – 97.08

Table 2b: Comparison of mean of various dimensions of present study with other studies

Sr. No.		Mean transverse diameter of body of S1 (mm)	Mean AP diameter of body of S1 (mm)	Mean length of Auricular surface (mm)
1	Present Study in Gujrat	Male – 46.53 Female – 30.85	Male – 29.89mm Female – 47.73mm	Male – 56.08mm Female – 54.73mm
2	Anil Kumar et al [19](2013)	Male – 53 Female – 51.4	Male – 30.6 Female – 30.5	
3	Maddikunta V et al[16] (2014) Study in Telangana	Male – 48.7 Female – 44.9		
4	Mishra et al[8] (2003)	Male – 49.12 Female – 42.81	Male – 30.03 Female – 29.29	Male – 62.54mm Female – 57.02
5	Raju and Singh[3] et al (1981)	Male – 47.33 Female - 42.18	Male – 30.30 Female – 27.63	
6	Flander et al [11] (1978)	White Americans Male – 52.78 Female – 46.56 Black Americans Male – 54.50 Female – 47.44	White Americans Male – 35.50 Female – 29.68 Black Americans Male – 33.58 Female – 28.80	
7	Stradalova et al[12] (1974)	Male – 51.39 Female – 47.28		Male – 62.45 Female -57.02
8	Davivongs et al[1] (1963) (Study on African Aborigines)	Male – 47.40 Female – 44.10	Male – 29.78 Female – 27.58	

Table 2c: Comparison of mean of sacral index of present study with other studies

Sr. No.		Mean Sacral Index	Sr. No.		Mean Sacral Index
1	Present Study	Male – 97.66 Female – 112.12	9	William F Manish[15] (2017)	Male – 97.88 Female – 112.69
2	UU Joshi et al[2] (2016)	Male – 102.31 Female – 117.58	10	Patel MM et al[9] (2005) Study in Gujarat	Male – 96.25 Female – 113.25
3	A K Arora et al[20] (2010)	Male – 93.7 Female – 125.4	11	Kataria et al [14](2014) Study in Rajasthan	Male – 104.11 Female – 120.01
4	Anil Kumar et al[19] (2013)	Male – 97.51 Female – 117.35	12	Mishra et al [8](2003)	Male – 98.21 Female – 117.84
5	Shailendra Patel et al[18] (2014)	Male – 97.61 Female – 113.4	13	Raju and Singh et al[3] (1981)	Male – 100.85 Female – 111.39
6	Arpan Dubey et al[5] (2016)	Male – 93.8 Female – 110.63	14	Flander et al [11](1978)	White Americans Male – 106.49 Female – 108.49 Black Americans Male – 106.17 Female – 112.35
7	Shweta Asthana et al[17] (2014)	Male – 96.25 Female – 113.33	15	Davivongs et al (1963)[1] (Study on African Aborigines)	Male – 104.16 Female – 115.49
8	Maddikunta V et al[16] (2014) Study in Telangana	Male – 91.8 Female – 116.3	16	Grays Anatomy[13](2008)	Male – 105 Female – 115

Table 2d: Comparison of mean of curvature and corporobasal index of present study with other studies

Sr. No.		Mean Sacral Index	Sr. No.		Mean Sacral Index
1	Present Study	Male – 97.66 Female – 112.12	9	William F Manish[15] (2017)	Male – 97.88 Female – 112.69
2	UU Joshi et al[2] (2016)	Male – 102.31 Female – 117.58	10	Patel MM et al[9] (2005) Study in Gujarat	Male – 96.25 Female – 113.25
3	A K Arora et al[20] (2010)	Male – 93.7 Female – 125.4	11	Kataria et al [14](2014) Study in Rajasthan	Male – 104.11 Female – 120.01
4	Anil Kumar et al[19] (2013)	Male – 97.51 Female – 117.35	12	Mishra et al [8](2003)	Male – 98.21 Female – 117.84
5	Shailendra Patel et al[18] (2014)	Male – 97.61 Female – 113.4	13	Raju and Singh et al[3] (1981)	Male – 100.85 Female – 111.39

6	Arpan Dubey et al[5] (2016)	Male – 93.8 Female – 110.63	14	Flander et al [11](1978)	White Americans Male – 106.49 Female – 108.49 Black Americans Male – 106.17 Female – 112.35
7	Shweta Asthana et al[17] (2014)	Male – 96.25 Female – 113.33	15	Davivongs et al (1963)[1] (Study on African Aborigines)	Male – 104.16 Female – 115.49
8	Maddikunta V et al[16] (2014) Study in Telangana	Male – 91.8 Female – 116.3	16	Grays Anatomy[13](2008)	Male – 105 Female – 115

The mean values of all the indices differ for different states in India as seen from Table 2b. The present study when compared with other studies indicates significant sexual, racial and regional differences in the metric parameters of the sacrum. If the gender detection is done based on the demarking points calculated for each parameter the chances of error in the inference is very less. The demarking points of various parameters if crossed by any sacrum will identify the sex with certainty which is important medico legally [2,21,22,23]. However, it is not necessary for any bone to cross the demarking points of all the parameters, if crossed would detect the gender with more accuracy [3,17]. Singh and Singh [10] have inferred that demarking point should be calculated separately for different regions of population because the mean of a parameter differs in values in different regions.

Conclusion

Based on the findings of the present study the female sacrum is wider but shorter than the male for functional reasons and in consequence of this sacral index is greater in the females. In the present study the sex difference of the sacrum according to sacral index is most significant ($P<0.00001$), but all indices, the straight length and curved length of the sacrum are significant parameters for the sex determination of the sacrum. However, not a single parameter could signify 100% gender discrimination. Hence it can be concluded that for the determination of the sex of the sacrum, maximum numbers of parameters should be taken into consideration to attain near to 100% accuracy.

Key Message

For the determination of the sex of the sacrum, maximum numbers of parameters should be taken into consideration to attain near to 100% accuracy.

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Original Article

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A Statistical Evaluation for Predicting the Stature Using the Facial Height by Regression Analysis

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Abstract

Aims: To predict the stature using the facial height by regression analysis. *Methods and Material:* The subject's Stature was measured by a stadiometer and the facial height by a vernier calliper in 150 medical students. *Statistical Analysis used:* The data was analyzed statistically by regression analysis. *Results:* Based on the linear regression analysis, stature would increase by 7.09 cm and 7.07cm for each cm increase in facial height in males and females respectively ($P < 0.001$). Mean stature was 167.54±9.59 cm and mean facial height was 10.77±0.76 cm. The P value was less than 0.001. This shows a significant positive correlation between stature and facial height. *Conclusions:* Estimation of stature from facial height could be performed where only unknown head and face are brought for anthropometric examinations.

Keywords: Stature; Facial Height; Regression.

Introduction

Stature is one of the primary characteristics of identification. Determination of individuality of a person is Personal identification. Personal identification is of two types i.e. complete (absolute) and incomplete (partial). Absolute fixation of individuality of a person is complete identification. To know only some facts about the identity of the person is partial identification [1]. Facial height is one of the important somatometric body dimensions [2].

Height or stature is an important anthropometric parameter in the personal details of any individual. Many anthropometric studies have been performed to establish relationship between stature and length of the long bones and other body dimensions such as arm length. However, researches that correlate facial height and stature are uncommon [3].

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Anthropometric techniques have been applied to find body size for more than hundred years. With an increase in mass disasters, the identification of the stature of the person became quite difficult task [4].

Earlier, researchers have utilized many bones of human skeleton such as long bones to short bones to find the stature of a person. They concluded that the stature can be estimated even from the smallest bone. Some scientists have used fragments of the long bones for the estimation of stature [5].

Many authors have performed studies for the estimation of stature from various body parts like hands, trunk, intact vertebral column, upper and lower limbs, individual long and short bones, foot and footprints. But only a few researches have been done on cephalofacial dimensions of the facial height with respect to estimate the stature [6-12].

Materials and Methods

Present study was conducted in the department of Anatomy at Hind Institute of Medical Sciences, Sitapur UP (India). A total of 150 medical students (107 males and 43 females) participated in this study as subjects. They were aged between 18 to 25 years. Subjects with the history of abnormal neurological findings affecting the facial dimensions, oculofacial trauma and craniofacial deformities were excluded from the study.

Inclusion Criteria

1. Subjects in age group of the 18-25 years.
2. Healthy adult subjects without any skeletal deformities (dwarfism and gigantism).
3. Subjects being able to stand in an erect posture without any spinal or muscular pathology.

Exclusion Criteria

1. Subjects with spinal deformities like kyphosis, lordosis and scoliosis.
2. Subjects with facial deformities that can affect facial height.
3. Individuals with craniofacial deformities (congenital or acquired)
4. Individuals with abnormal neurological findings (such as facial palsy, ptosis and squint)

Equipments used in the Study

- Stadiometer
- Vernier caliper
- Digital camera

Somatometric Parameters

- Stature
- Facial Height

Stature and Facial Height are measured for all the participants according to the standard anthropometric methods of the International Society for the Advancement of Kin anthropometry [13].

Informed consents were taken from the subjects. The (anthropometric variables) facial height and the stature were measured.

Definition of Stature

It is the distance from the plane where the individual stands to the vertex (the highest point on head when the head is in eye ear plane) .The individual should be in erect posture [14].

Procedure for Measurement of Stature

Stature is measured to the nearest 0.1 centimetres (cm) in bare feet with the subject standing upright against a stadiometer. The subjects head has to be in the Frankfort horizontal plane. This is achieved when the lower edge of the eye socket (the orbitale) is horizontal with the tragion (A point in the depth of notch just above the tragus of the ear). The subjects are said to stand erect with his heel together and his backs straight as possible so that his heels, buttocks, shoulders and the head touches the rod of stadiometer. The arms are hung freely by the sides. Asking the subject to take a deep breath and hold it, a reading is taken from the stadiometer scale at his vertex point. The subject is then told to breathe and to step away from floor of stadiometer [15].

Definition of Facial Height

The distance from the nasion (the nasal root) to the gnathion (the lowest point on the lower border of the mandible in the mid sagittal plane) [14].

Procedure for Measurement of Facial Height

The subject was asked to sit on a chair with the head facing forward. From nasion to gnathion, the two sliding ends of the vernier caliper were placed. The vernier caliper was then removed from the face and the facial height was recorded in nearest mm, which is the straight distance from the nasion to the gnathion [16].

Statistical Analysis

The data thus collected was subjected to statistics like mean, standard deviation, Karl Pearson's correlation coefficient, regression analysis, standard error of estimate etc. and were analyzed using SPSS (Statistical Package for Social Sciences) on windows XP professional.

Results

The study was conducted on 107 Male and 43 Female students, age range (18-25 yrs). The Sample size with mean age is shown in Table 1.

Table 2 showing mean stature and mean facial height are (167.54±9.59) cm and (10.77±0.76) cm respectively ($p<0.001$ and Pearson's coefficient 'r'=0.34). Therefore, there is a significant positive correlation between body height and facial height.

Table 3 shows regression equation to calculate stature from facial height (FH) in males. A hypothetical regression equation is depicted as follows: Stature = a + bx where 'a' is the regression coefficient of dependent variable i.e. stature and 'b' is the regression coefficient of independent variable (facial height), 'x' is facial height.

The Table 3 also presents the standard error of estimate (SEE) calculated regression formula for estimation of stature. The SEE tends to predict the deviation of estimated stature from the actual stature. A low value is indicative of the greater reliability of prediction and the higher value of SEE denotes less reliability of prediction [17]. SEE is 5.39 in cases of males.

Table 4 shows regression equation to calculate stature from facial height (FH) in females. A hypothetical regression equation is depicted as follows: Stature = a + bx where 'a' is the regression coefficient of dependent variable i.e. stature and 'b' is the regression coefficient of independent variable (facial height), 'x' is facial height.

The Table 4 also presents the standard error of estimate (SEE) calculated regression formula for estimation of stature. The SEE tends to predict the deviation of estimated stature from the actual stature. A low value is indicative of the greater reliability of prediction and the higher value of SEE denotes less reliability of prediction. (17). SEE is 4.34 in cases of females.

In the Table 5, the minimum, maximum and mean values of the measurements were substituted in regression equation and estimated stature was calculated. It is evident from the table that minimum estimated stature is greater than the actual minimum stature whereas maximum estimated stature is less than the actual maximum stature. Mean estimated values are closest to the actual stature.

In the Table 6, minimum, maximum and mean values of the measurements were substituted in regression equation and estimated stature was calculated. It is evident from the table that minimum estimated stature is greater than the actual minimum stature whereas maximum estimated stature is less than the actual stature. Mean estimated values are closest to the actual stature.

Table 7 shows the difference between the mean actual stature and mean estimated is 0.48 which is statistically insignificant

Table 8 showing the difference between the mean actual stature and mean estimated stature as 0.07 which is considered as negligible and statistically insignificant.

In Table 9, a simple linear regression was calculated to predict stature (as dependent variable) based on facial height (independent variables) separately in males. Based on the linear regression analysis, stature would increase by 7.09 cm for each cm increase in facial height ($P < 0.001$) in males.

In Table 10, a simple linear regression was calculated to predict stature (as dependent variable) based on facial height (independent variables) separately in females. Based on the linear regression analysis, stature would increase by 7.07 cm for each cm increase in facial height ($P < 0.001$) in females.

Table 1: Sample size

Sample	No. of Subjects	Mean Age (Years)
Medical Male Students	107	22.36 ± 1.21
Medical Female Students	43	20.36 ± 1.29

Table 2: Descriptive Statistics of Stature and Facial Height

S.N.	Variable	Mean	Median	Mode	Standard Deviation	Pearson's Coefficient 'r'	P-value
1.	Stature (cm)	167.54	168	173	9.59		
2.	Facial Height (cm)	10.77	10.8	10.8	0.76	0.34	<0.001

Table 3: Regression equation for estimation of stature (cms) from facial height in males

Regression Equation	**SEE
Stature = 154.32+ 1.391(FH)	5.39

*FH= Facial Height
**SEE = Stand Error of Estimate

Table 4: Regression equation for estimation of stature (cms) from facial measurements in females

Regression Equation	**SEE
Stature = 148.63+ 0.742(*FH)	4.34

*FH= Facial Height
**SEE = stand error of estimate

Table 5: Comparison of actual stature and estimated stature from facial height in males using regression analysis

Estimated stature using regression equation	Minimum estimated stature	Maximum estimated stature	Mean estimated stature
Facial height	165.12	171.51	168.32
Actual stature	152	189	168.70

Table 6: Comparison of actual stature and estimated stature from facial measurements in females using regression analysis

Estimated stature using regression equations	Minimum estimated stature	Maximum estimated stature	Mean estimated stature
Facial height	153.91	156.94	155.43
Actual stature	129	182	155.50

Table 7: Comparison of mean actual stature (168.70 cm) and mean estimated stature in males

Estimated stature using regression equations for (in cm)	Mean estimated stature	Difference between means=mean actual stature – mean estimated stature
facial height	168.32	0.48

Table 8: Comparison of mean actual stature (155.50 cm) and mean estimated stature in females

Estimated stature using regression equations for (in cm)	Mean estimated stature	Difference between means=mean actual stature – mean estimated stature
facial height	155.43	0.07

Table 9: Linear regression analysis with stature (dependent variable) and facial height (independent variables) in males Dependent variable: Stature (cm)

Independent variables	Unstandardized coefficient (β)	95% CI	R-squared	P-value
Facial height (cm)	7.09	5.54 – 8.61	0.376	<0.001

CI= class interval

Table 10: Linear regression analysis with stature (dependent variable) and facial height (independent variables) in females Dependent variable: Stature (cm)

Independent variables	Unstandardized coefficient (β)	95% *CI	R-squared	P-value
Facial height (cm)	7.07	5.52 – 8.56	0.366	<0.001

*CI= Class Interval

Table 11: Showing Comparison between Various Studies done by Different Authors with Our Study

Authors/year	Mean body height (cm)	Mean Facial height (cm)	P value	Pearson's coefficient 'r'value
Jadav HR and Shah GV (2004)	168.10	-	-	-
Jibonkumar and Lilinchandra (2006)	162.29±0.38	11.25±0.437	<0.001	0.213
Swami S, Kumar M and Patnaik VVG (2015)	-	-	<0.001	-
Yadav SK et al (2015)	162.70 ± 8.45	10.70 ± 0.73	<0.001	0.61
Kumar M and Patnaik VVG(2013)	-	-	<0.001	-
Our study	167.54±9.59	10.77±0.76	<0.001	0.34

Discussion

All the measurements were found to be more in males as compared to females. These observations were in concordance with the earlier studies. Such standards based on ethnic or racial data are desirable because these standards reflect the potentially different patterns of craniofacial growth resulting from racial, ethnic and sexual difference. The study

provides correlation between the facial measurements with stature and also devises regression equations to calculate stature from these measurements as it is the best method as far the accuracy or reliability of the estimate is concerned [18].

The dimensions of anthropometry are different for age, sex, body size, race, ethnic groups, geographical location, dietary variation and even religion. Despite of this variation, height has been measured from many other parameters of the human body by refining formulae. The obtained data have become very much important in identifying the persons. The body height of a person is genetically predetermined and is an inherent characteristic. Estimation of height is taken an important parameter in the identifying unknown remains of human beings [19,20,21].

Craniofacial anthropometry has become an important tool for genetic counsellors and reconstructive surgeons. It is necessary in genetic counselling, to recognize dysmorphic syndromes as accurately as possible. Many dysmorphic syndromes are diagnosed on the basis of advanced cytogenetic and molecular techniques, but also on identification of various morphological anomalies in craniofacial region. The values obtained in the normal population can be compared with the measurements taken from the patients. Thus, deviations from the normal values can be calculated. Therefore, anthropometric data can be used in early diagnosis of common syndromes. It was observed that children with partial foetal alcohol syndrome and foetal alcohol syndrome had a special facial phenotype that could be defined anthropometrically [22].

In our study mean body height and mean facial height is found to be (167.54±9.59) cm and (10.77±0.76) cm respectively ($p<0.001$ and Pearson's coefficient 'r'=0.34). Thus, there is a significant positive correlation between body height and facial height.

In Gujarat Region, Jadav HR and Shah GV derived the body height from the length of head. They observed that the mean body height was 168.10 cm in Gujarati male medical students with their last age range 22 years [20].

Jibonkumar and Lilinchandra conducted study among the Kabuis Naga of Imphal Valley, Manipur. They observed mean body height was (162.29±0.38) cm and facial height was (11.25±0.437) cm. P value was less than 0.001 and Pearson's coefficient was 0.213.Therefore, there was a significant correlation between the two parameters [14].

Swami S, Kumar M and Patnaik VVG conducted anthropometric study in adult Haryanvi Baniyas. There was also observed a significant positive correlation in both sexes [18].

Yadav SK et al. also found statistically significant positive correlation between the body height and the other cephalometric variables in Nepalese population. The observed parameters were; Mean Height (cm) =162.70±8.45, Facial Height (cm) =10.70±0.73, ($p<0.001$ and Pearson's coefficient 'r'=0.61) [3].

Kumar M and Patnaik VVG estimated the body height from Cephalo-Facial Anthropometry in 800 Haryanvi Adults. Their results showed a significant positive correlation between stature and all cephalo-facial measurements except for maximum head breadth which showed an insignificant correlation with stature in both sexes [23].

The regression formulae obtained for estimation of stature from facial height were checked for their accuracy. Table 5 and Table 6 show a comparison of actual stature and stature estimated from facial height using regression analysis. The mean estimated stature values were close to the actual stature in both males and females. While applying these formulae one should keep in mind that these are population specific.

Since regression equations are known to be population and sex specific, there is a need for similar equations to be derived for other endogamous groups [23].

Krishan and Kumar reported 4.41–7.21 cm SEE in estimating stature from sixteen cephalo-facial measurements in their sample on Koli male adolescents of north India [24].

Ryan and Bidmos presented SEE from 4.37 to 6.24 cm in their study on estimation of stature from skulls of indigenous South Africans from Raymond Dart's collection [25].

In the present study, the value SEE is comparatively lower than these studies, i.e. from 4.34 to 5.39 cm in females and males respectively. In other words, in the present study, the stature estimation from cephalo-facial dimensions has greater reliability of estimate when compared with other similar studies.

Conclusions

Estimation of stature from facial height could be performed where only unknown head and face are brought for anthropometric examinations.

It is further concluded that the calculated regression formulae show good reliability and applicability of estimate not only in the sample which was used by earlier researchers (genetically

homogeneous population) in the calculation of the regression formulae but also in samples taken from mixed population (genetically heterogeneous population) as in present study.

While applying these formulae, one should keep in mind that these are population specific; these cannot be used on other populations of the world.

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Manuscript, presented as part at a meeting, the organization, place – nil

Key Message

Estimation of stature from facial height could be performed where only unknown head and face are brought for anthropometric examinations. Regression formulae show good reliability and applicability of estimate. While applying these formulae, one should keep in mind that these are population specific; these cannot be used on other populations of the world.

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Morphometric Study on the Dimensions of Upper End of Tibia in Wayanad Population

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Abstract

Introduction: Arthritis and injuries of a knee joint is a common problem encountered during the old age which requires total knee replacements and Unicompartmental kn ee arthroplasty. Morphometric parameters of condyles of the tibia can be useful for the treatment and monitor the outcome of these surgeries by selecting specific knee prosthesis for that particular population. *Aims:* To measure the various parameters of the proximal end of the tibia in Wayanad population. *Methods:* In the present study, sixty-eight (30-right and 38-left) adult fully ossified tibia were taken and various parameters of the upper end of the tibia were measured using Vernier caliper. Statistical analysis of this data was done using SPSS software version 16. *Results:* The present study was done on both left and right tibia. The following data was obtained.

On Left side: Mean ±SD of circumference -18.59±1.7cm,

Surface area of medial condyle-13.23±2.53cm^2,

Surface area of lateral condyle- 12.19±2.56cm^2 and

Intercondylar surface area- 4.93±1.16 cm^2.

On Right side: Mean ±SD of circumference-18.5± 1.3cm,

Surface area of medial condyle-12.85±2.44 cm^2,

Surface area of lateral condyle-12.06±2.46cm^2 and

Intercondylar surface area-5.06±0.81cm^2

Conclusion: Knowledge about the dimensions of the upper end of the tibia will be helpful for anatomists, anthropologists, and Orthopedicians in cases of knee arthroplasty procedures, Unicompartmental knee arthroplasty, and meniscal transplantation.

Keywords: Morphometric; Synovial joint; Arthroplasty; Meniscal transplantation

Introduction

The knee joint is a complex synovial joint consisting of the femorotibial and femoro patellar articulations. It functions to control center of body mass and posture in the daily activities. This necessitates a wide range of movements in three dimensions coupled with the ability to withstand high pressure. The mobility and stability add are achieved by the interaction between the articular surfaces, the passive stabilizer and the muscles that cross the joint. The relatively incongruent nature of the joint surface makes the knee joint inherently unstable [1].

Several forms of arthritis such as inflammatory and posttraumatic arthritis due to a regular playing of many sports like football and also osteoarthritis is the most common pathological disorder which affects the knee joint. The treatment for that is usually total knee arthroplasty (TKA) [2].

TKA has undergone improvements by recent technological progressions in prosthetic design,

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instrumentation, surgical techniques and rehabilitation [3]. TKA is a precision operation requiring precise soft tissue balancing and resection of bone thickness equal to the thickness of the prosthetic component implanted, so that the flexion-extension spacing are equal, permitting joint stability throughout the range of motion. Prosthetic selection, accurate sizing and proper placement of the components decide the success of this procedure. The A-P measurement of prosthesis is significant in sustaining flexion-extension spacing while the mediolateral measurement decides satisfactory coverage of the resected bone and tension free wound closure [4].

In Unicompartmental arthritis of the knee in elderly patients, the treatment of choice is Unicompartmental knee arthroplasty [5]. The prosthesis which is presently being used in the practice is best suited for the western population, therefore, leading to implant size incompatibility with the resected bony surfaces [6].

So, the aim of the present study was to measure various parameters of the proximal end of the tibia in Wayanad population.

Materials and Methods

In the present study, sixty-eight (30-right and 38-left) adult fully ossified tibia were taken from Department of Anatomy, DMWIMS, Wayanad, Kerala. Various parameters like A-P and transverse diameter of the medial, lateral and Intercondylar area of the tibia were measured using Vernier caliper. Area of the condyles and Intercondylar area were measured using the formula: Area of condyle = Anterior-posterior length (A-P) × Transverse diameter (TD) of the condyle.

The circumference of the tibia was measured using a measuring tape. Statistical analysis like mean and Standard deviation of this data was done using SPSS software version 16.

All the measurements were taken by a single author in order to minimize human error. After obtaining the results, was plotted for better interpretation of the results.

Results

The Data and statistical analysis are shown in Table 1 and 2:

Table 1 Showing the Mean and Range of all morphometric parameters of the Right and left tibia. The 'p' value is >0.05 so there is no significant difference between the measurement of right and left side tibial measurements as shown in Table 2.

Fig. 1: Showing the measurement of the circumference of Tibia using a measuring tape

Fig. 2: Showing the measurement Anterior –posterior diameter of the medial condyle of the tibia using vernier caliper

Discussion

In the design process of the tibia prosthesis for TKA we should be aware of the geometry and anatomy of the knee which is variable, irrespective of gender and the human race [4].

According to the present study, the tibial circumference was less in Wayanad population when compared to study of Ivan et al. [3] and Gupta

Table 1: The Mean and Range of all morphometric parameters of the Right and left tibia

Parameters	Right Tibia Measurements (Mean ± SD in cm)	Left Tibia Measurements (Mean ± SD in cm)
A-P length of Medial condyle	4.44±0.4	4.52±0.4
Transverse diameter of medial condyle	2.87±0.3	2.90±0.3
A-P length of lateral condyle	4.10±0.4	4.13±0.4
Transverse diameter of lateral condyle	2.92±0.3	2.92±0.4
A-P length of Intercondylar area	4.69±0.4	4.47±0.5
Transverse diameter of Intercondylar area	1.08±0.2	1.09±0.2
A-P length of articular part of Medial condyle	3.57±0.4	4.08±0.4
A-P length of articular part of lateral condyle	3.60±0.4	3.99±0.4

Table 2: The Mean and range of circumference of the upper end of the tibia, the surface area of lateral condyle, medial condyle and intercondylar region of right and left tibia with 'p' value.

Parameter	Right Side Tibia	Left Side Tibia	P value
Mean ± SD of Tibial circumference in cm	18.5± 1.3	18.59±1.7	0.877
Surface area of medial condyle in cm^2	12.85±2.44	13.23±2.53	0.539
Surface area of lateral condyle in cm^2	12.06±2.46	12.19±2.56	0.840
Intercondylar surface area in cm^2	4.93±1.16	4.93±1.16	0.612

et al. [2] as shown in Table 3 this may be due to racial variation in built of the individual.

In the present study, the surface area of the medial condyle of the tibia was more when compared to the previous study as shown in Table 4. The surface area of lateral condyle of the tibia in the present study was more than the previous study as shown in Table 5.

In clinical practice, surgeons do not favor implants with insufficient tibial coverage as this induces the possibility of tibial implant collapse [5,6]. There is a need for standardization of size of the prosthesis depending on the region and race.

It was reported that parameters differ from the medial and lateral compartment. So, the present study has reported the morphometry of tibial condylar and the intercondylar area which will be helpful for the surgeon to select suitable size prosthesis in case of knee replacement surgery.

The study will provide guidelines for designing appropriate Tibial unicompartmental knee arthroplasty and complete knee arthroplasty component because few studies in which the failure of Unicompartmental knee arthroplasty occurred due to implant loosening [4].

Table 3: The comparison of Tibial circumference in different studies

Studies	Left Tibia (circumference in cm)	Right Tibia (circumference in cm)
Ivan. et.al study[3] (2014)	19.36±1.5	19.33±1.44
Chandni Gupta.et.al study[2] (2015)	19.07±1.65	18.95±0.68
In present study (2017)	18.59±1.7	18.5±1.3

Table 4: The comparison of the surface area of the medial condyle of the tibia in different studies

Studies	Left Tibia	Right Tibia
Srivastva.et.al study4 (2014)	(Area in cm2)	(Area in cm2)
Chandni Gupta.et.al study 2(2015)	11.01	11.52
In present study(2017)	12.12±2.12	12.30±1.45

Table 5: The comparison of the surface area of lateral condyle of the tibia in different studies

Studies	Left Tibia (Area in cm^2)	Right Tibia (Area in cm^2)
Srivastva.et.al study[4](2014)	10.52	10.75
Chandni Gupta.et.al study[2](2015)	11.92±2.09	10.89±1.44
In present study(2017)	12.19±2.56	12.06±2.46

Conclusion

The Knowledge about the dimensions of the upper end of the tibia will be helpful for anatomists, anthropologists, and Orthopedicians in cases of knee arthroplasty procedures like Unicompartmental knee arthroplasty and meniscal transplantation.

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Histogenesis of Liver in Human Fetuses

Manirul Islam

Abstract

Introduction: The present study attempted to find out the histological changes of liver during its development in human fetuses. *Methods:* Liver from 10th–40th GW fetuses were studied after staining with Hematoxylin and Eosin, and Masson's Trichrome stains. *Results:* The liver from 10th week onwards to term consists of two different cellular elements, larger cells with pale staining centrally located nuclei, hepatocytes and dark staining smaller cells with dark rounded nuclei, the haemopoietic cells. The haemopoietic cells occupy larger area from 10th week onwards till 22nd week when both the elements are equal in quantity, after that hepatocytes quantity increases gradually and the haemopoietic cells decreases in amount and at term only little haemopoietic cells remains. Sinusoids are irregular and having wide lumen from 10th to 18th week, after that the lumen become narrow and regular. Within the sinusoids lies the haemopoietic cells and all the sinusoids are lined by fenestrated endothelium. Hepatic lobules become apparent after 22nd week and kupffer cells appear after 25th week. Bile duct, hepatic artery and portal vein all identified from 14th week onwards till term. *Discussion:* During early development, liver was composed of collagen fibers with fibroblast cells, hepatocytes and bigger haemopoietic cells. Haemopoietic cells could be detected till 36th GW fetuses. Even though immature RBCs and haemopoietic stem cells were detected, hemopoiesis in the liver along with it hepatocytes could be ascertained in the present study.

Keywords: Haemopoietic Cells; Hepatocytes; Kupffer Cell; Stem Cell; Haemopoiesis.

Introduction

The earliest development of the liver in human is indicated by the appearance of the hepatic diverticulum, first recognizable as an anlage lying ventral to the endoderm of the foregut in the anterior intestinal portal in 5 somite embryo (2mm). This diverticulum is an endodermal thickening known as hepatic endoderm, originating from the primitive streak and is believed to be induced by mesoderm in the cardiac area [1]. The combined anlage of the bile duct and liver is known as hepatic diverticulum. The hepatic duct and glandular tissue develops from the cranial portion of the hepatic diverticulum [2]. The hepatic diverticulum consists of rapidly proliferating endodermal cells lining the primitive foregut and gives rise to cellular branches which invade the mesenchyme of septum transversum. These cellular branches are termed hepatic cords and they intermingle with the umbilical and vitelline veins forming the hepatic sinusoids. Liver cords differentiate into the parenchyma and forms the lining of the biliary ducts. Haemopoietic cells, kupffer cells and connective tissue cells are derived from the mesoderm of the septum transversum [3]. The mesenchyme of the septum transversum forms the endothelial cells and the connective tissue frameworks of the liver and the endoderm differentiates into hepatocytes. The proliferation and bulging of the hepatic diverticulum stimulates the production of blood islands in the investing mesenchyme [1]. The liver remains proportionately large during its development and constitutes a sizeable organ dorsal to the heart at stage 14 then more caudally placed by stage 164 [5]. By this stage hepatic ducts can be seen separating the hepatic epithelium from the extra hepatic biliary system [6]. At 3 months' gestation, the liver almost fills the abdominal cavity and its left lobe is nearly as large as

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its right and it constitute 10% of the whole body weight [7,8]. Although its haemopoietic functions cease before birth its enzymatic and synthetic functions are not completely mature at birth [4].

Materials and Methods

The material studied consisted of seventy two (72) normal fresh human fetuses, of different gestational ages ranging from 10 weeks (CRL-6cm) to 40 weeks (CRL-39.5cm), collected from the Department of Obstetrics and Gynecology, RIMS, Imphal, which were the products of terminated pregnancy under the Medical Termination of Pregnancy act of India, 1971 and stillbirths. The specimens were utilized for the present study after seeking permission from the institutional ethical committee. The age of the fetuses were calculated from the obstetrical history, gross features and crown-rump (C.R.) lengths. Thereafter they were fixed in neutral buffered formalin for two to seven weeks and then the dissection was carried out.

Only those fetuses which were free from any gross anatomical abnormality were selected for the present study. The specimens were categorized into different age groups for easier study and observation as there will be similar features and finding in the adjacent age groups. After proper fixation, the tissue were trimmed and cut and prepared for histological studies. The slides were stained with routine haematoxylin and eosin staining. Van Giesons staining were also done to differentiate the collagen fibres and reticulin fibres. Slides were then examined for general morphology and cellular details under low power (10X), high power (40X) and oil immersion (100X).

Results

10 to 16 weeks

In the panoramic view, hepatic parenchyma is recognized with both cellular and fibrous component, where plates of hepatic cells are arranged in linear and branching pattern and anastomosing between each other (Fig. 1a). There is homogenous parenchyma with early sign of lobulation indicated by tiny central vein in the centre (Fig. 3a), inside the lobule hepatocytes are in different stages of differentiation showing labyrinthine network as well as cord like pattern interspersed with haemopoietic cells within the space, the future sinusoids (Fig.1b). In between the cords there are spaces where other different types of cell are present (Fig. 2a). In the plates of cell there is presence of epitheloid glandular cell with early myocytes, also some mesenchyme to fibroblast cells. The hepatic lobule is yet to appear clearly and the kupffer cells are not yet developed. There are no interlobular septa in between the immature lobule. The capsule of the liver is poorly defined and it is made up of single layer of cell with flattened nuclei and there are thin layer of connective tissue demonstrated by Van Gieson's stain(Fig. 4a).

17 to 20 weeks

Hepatic parenchyma is recognized with a number of incomplete hepatic lobule, the shape of which ranges from circular to polygonal with ill defined

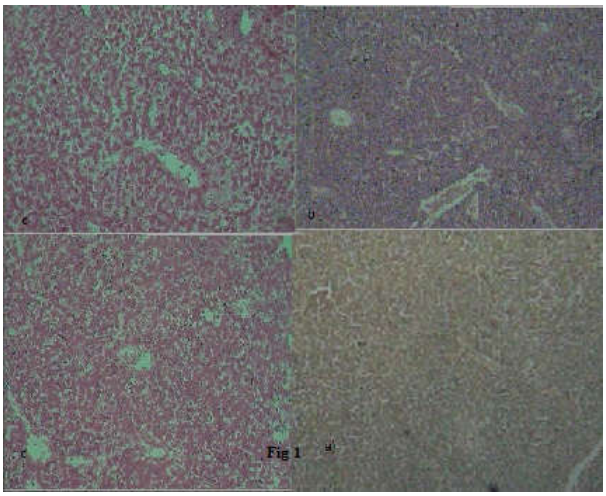

Fig. 1a: Panoramic view showing initial lobulation at 10th week
b. Showing the appearances of proper central vein and hepatic triad area at 14th week
c. Showing the sinusoidal appearance and network of hepatic cords at 22wk
d. Increase in size of the individual lobule at term liver

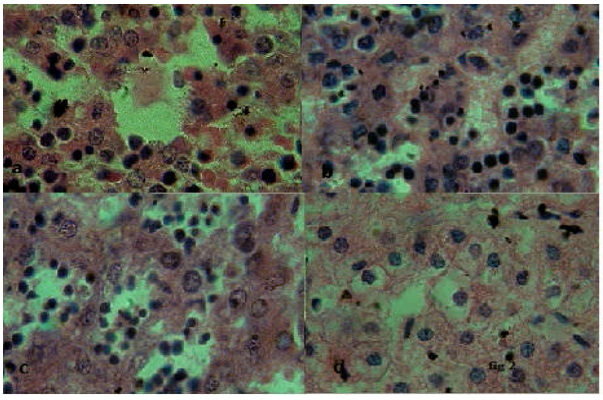

Fig. 2a: Showing irregular hepatic cords with 2-3 cell thick at 14th week
b. sinusoids are filled with haemopoietic cell, darker than hepatic cells at 20th week
c. anastomotic network of sinsuoids and hepatic plates at 30th week
d. well defined hepatocytes and hepatic plates are at 40th week

portal triad in the corner. Each lobule has rows of hepatocytes arranged radially from the central vein and separated from each other by empty spaces, future sinusoids (Fig. 2b). The hepatic columns are more in number and there is increase number of hepatocytes around the central vein. Haemopoietic cells are dominant in the parenchyma. There are empty spaces between the hepatic plates, these spaces are future sinusoids(Fig. 2b). In these sinusoidal spaces, there are abundant darkly nucleated smaller group of cell, haemopoietic in origin. The sinusoidal spaces are very prominent near the central vein but it is less obvious peripherally. The capsule is well defined and consists of connective tissue fiber and single layer of flattened cells as identified by Van Gieson's and Massons Trichrome stain (Fig. 4b).

21-24 weeks

The lobulation is better identifiable than the previous age group fetuses. Hepatic plates are 2-3 cells thick and shows irregular branching pattern and in between the plates there are sinusoids, filled with abundant dark staining cells, which are developing blood cells in various stages of maturation (Fig. 1c). The parenchymal tissue is more than previous age group but the sinusoidal spaces are less abundance. Portal area is recognized with a number of structures within connective tissue fiber which are both mature and immature. Some of the hepatic plates as well as sinusoids are continuous with surrounding lobule indicating immaturity of the lobule. The hepatocytes are round to ovoid in shape with spherical and vesicular nuclei (Fig. 1c).

The cell boundary is better defined in this age group than the previous weeks. The nucleus is lightly stained and occasionally presents bi-nucleated appearance but number of bi-nucleated hepatocytes reduced than the earlier weeks. Kupffer cells are appears for the first time at 22nd week in the sinusoidal wall (Fig. 3b). Kupffer cells are identified as larger cells with irregular and elongated nuclei which stained darker than the endothelial cells.

The hepatocytes and haemopoietic cells are almost equal in number, but the hepatic plate's areas are more than the sinusoidal areas (Fig. 5a). Elastic lamina is seen around the central vein and surrounding the hepatic artery in a small amount by Voeroff's stain. The capsule is well developed with thick connective tissue fiber.

25 to 32 weeks

Hepatic lobule is well organized and hepatocytes are seen to arrange in columns, which form

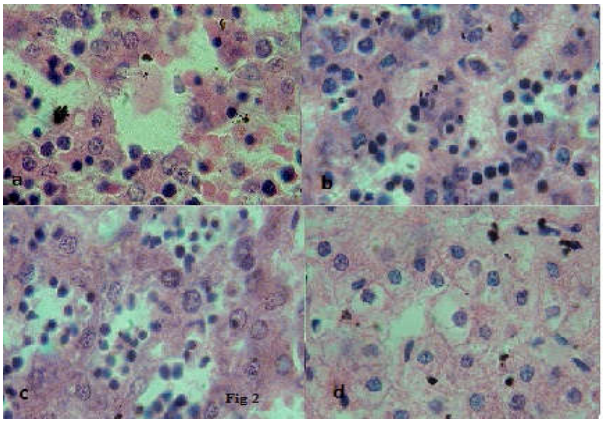

Fig. 3a: Irregular sinusoids and ill defined central vein at 14th week
b. Trabeculated appearance of hepatic cords with abundant haemopoietic cells and kupffer cell at 22nd week
c. Reduced haemopoietic cells at 30th wk
d. Abundant hepatocytes and kupffer cells with less blood cells at term liver

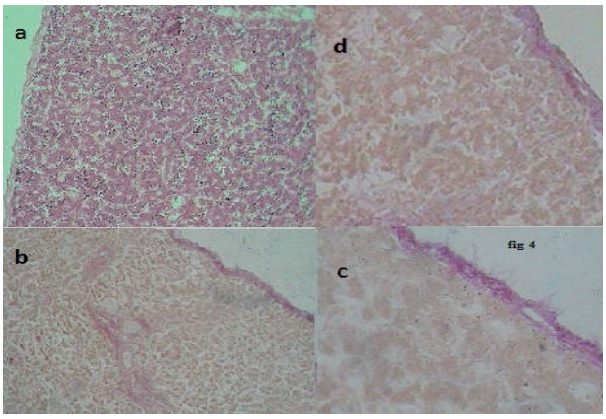

Fig. 4a: at 14th week ill defined thin hepatic capsule
b: Increase thickness of capsule with connective tissue element at 18th week
c & d: Well defined capsule at 30th and term liver

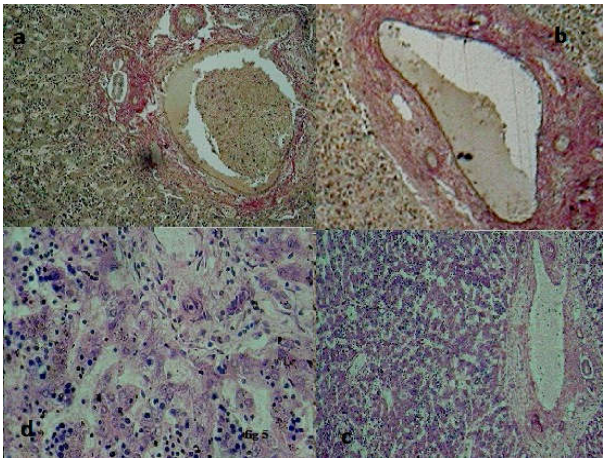

Fig. 5a: Developing portal triad area at 22nd week, showing irregular and immature connective tissue cell
b: at 26th week definite pattern has been formed
c: Well defined portal triad area at 34th week
d: Term liver showing endothelial cells, kupffer cells and hepatocytes near the portal area

multiple branching pattern. Bile ductules are seen in the portal areas with spherical nucleus and cuboidal epithelium (Fig. 2c). Individual hepatocytes and cell boundary are better defined in this age group. Near the central vein, the hepatic plates are arranged as cords but towards the periphery they are arranged as branching pattern. Haemopoietic cells presents near the central vein are very less and are smaller than the hepatocytes having dark staining round nuclei (Fig. 3c). Portal area shows connective tissue elements, mostly mesenchymal cells with spherical nucleus and some fibroblast cells (Fig. 5b).

33 to 38 wks

The size of the lobule as well as the central vein is larger than the previous age group and the sinusoids are better defined. Surrounding the portal triad, hepatic plates are solid with no or little intervening sinusoids. Hepatic cords are 1-3 cell thick and they shows branching pattern. Individual hepatocytes are round to polygonal in shape with vesicular nucleus which is round and eosinophilic in character (Fig. 5c). The hepatocytes are irregularly arranged and lined by flattened cell with flattened nuclei, these cells are endothelial cells. Between the lining endothelium and hepatocytes a small space is present, known as perisinusoidal space. Inside the lumen of the portal vein, there are both nucleated and non-nucleated erythrocytes (Fig. 4d).

Term Liver

The liver parenchyma is almost like adult liver architecture but the hepatic lobules are smaller in size. Boundaries between the adjacent lobules are more prominent than the previous age group fetuses (Fig. 1d). The glandular elements increased much more than the sinusoidal area and the hemopoietic tissue still present although much lesser than the previous age group fetuses (Fig. 3d). The hepatic cords are one to two cells thick. In the portal area all the three structures are clearly visible, and the size of all the structures are almost adult shaped but smaller in diameter than the adult liver (Fig. 2d). Portal area shows abundant amount of connective tissue with extension towards the hepatic lobule although these extensions are very minimal in comparison to the adult liver (Fig. 5d). These areas also show presence of fibroblasts with round to spherical nuclei. These areas also show abundant amount and presence of muscular fiber as depicted by special staining method of massons Trichrome. The capsule is very well developed as identified by its thickness and increase in its layers of connective tissue (Fig. 4d).

Discussion

The report and data on the development of the liver in human fetus by various author revealed that hepatic primordium was derived from proliferation of cell from the blind end of a Y shaped diverticulum, which grows from the foregut into the septum transversum [9,10]. From the cranial part of that diverticulum the liver develops and the caudal part developed into gall bladder and bile ducts [6]. Liver primordium was first identified in a 5-somite embryo as a flat plate of endodermal cell lying ventral to the endoderm of the foregut at the anterior intestinal portal. The same result also obtained by other at 18cm CVR length fetuses [11,12]. In the present study, earliest fetus of our series the liver was easily identified and it was found occupying the abdominal cavity extending from the diaphragm above to the pelvic cavity below, similar findings was reported by Enas Abdul et al. [13]. During the early stage, at 10th week both the right and left lobes are identified and both are of same size. The liver of camel is covered by the thin Glisson's capsule, which first appeared in fetuses of 75mm CVR length [13]. The glisson's capsule was formed of only one layer of flattened cell with oval nuclei, the same result also observed by Moustafa et al in the dog [14]. In our present study, glisson's capsule was observed 14th week onwards till term. At 14th week it was very thin but gradually increased its thickness and term capsule is very prominent and thick.

From the 6th week onwards, the liver primordium was composed of two different cellular elements: the hepatocytes and the hemopoietic cells, in between there are irregular blood spaces. The haemopoietic cells appeared dispersed between the liver parenchyma [3,13]. From the 2nd to the 7th month, blood cells are actively differentiating between hepatic cords and the sinusoidal lining [1,15,16,17]. Hematopoesis begins during the sixth week [18]. Early in the development liver is the primary site of haemopoiesis; in the 7th week, hematopoietic cells outnumber the functioning hepatocytes in the parenchyma [19]. Our present study also supported the above statement as we observe in our series that, 10th week onwards liver parenchyma consists of 2 different cellular elements: hepatocytes and haemopoietic cells. Up to 16th week of gestation haemopoietic cells are more than the hepatocytes and after that hepatocytes element increase and at 22nd week both the elements are equal in the parenchyma.

At first the hepatic cells are small and irregular in shape and form an irregular network of cords separated by islands of hemopoietic cells, but there is little organization into plates and sinusoids that are clearly defined [20]. The hepatocytes were in the form of coalesced liver cords in 12th week onwards [21]. At 12th week there is proliferation of endodermal cells in the form of solid hepatic cords and at 14th week clusters of small mesenchymal cells arranged in the form of vesicles have been seen but endothelial lining was not visible. Hepatic cords were solid at first then acquired lumen [15]. Our present study also support the above statement as we found that at 14th week there is coalesced liver cord and the cords are irregular in shape extending from the central vein and shows anastomotic pattern and the cords are separated by irregular blood spaces. This finding support the above mentioned statement that, hepatic cords were solid at first and acquired lumen and this process start near the central vein towards the periphery.

According to Bates et al., the hepatic lobules are identifiable in the 6th gestational week [19]. Ansari et al stated that, hepatic lobule was measureable from 22nd week onwards in human fetuses [22], but Krause and Cuttis mentioned that the lobulation seen in the adult is not present in the developing embryos [20]. In our present study immature liver lobule was identified from 18th weeks onwards but there was no definitive intralobular boundary and sinusoids were continuous between adjacent lobule and definitive adult architecture was not achieved at term liver also. In fetal life, the hepatocytes plates are two cells thick, a normal finding up to age of 7 yrs [5,17,23]. In our present study we observe that the liver cords were 2-3 cells thick in the earlier period but gradually becomes 1-2 cells thick at term. Kupffer cells are derived from the mesoderm of the septum transversum [10] and kupffer cells appeared at 22nd week of gestation and their number increased till 34th week of gestation [13]. In our present study we observe kupffer cells at first after 25th week of gestation only.

Bile canalicular structure appear very early in the gestation at 6-7th week [19]. Intrahepatic bile duct formation is complete by 3rd month. Bile secretion is noted at 3rd month3 more precisely at the 12th gestational week [24,25]. But some author believes that major bile ducts at the porta hepatis are fully formed by the 16th week of gestation [17,24]. In our present study we found, bile duct in the portal area appeared in 14th week onwards but fully formed at 16th week similar to Vijayan et al. [25,26]. A given volume of liver is comprised of 50-70% of hepatocytes at midterm and 90-95% at term. The remaining cellular elements of those livers are hemopoietic cells which are arranged in clusters containing a variety of developmental stages [27,28,29]. With the increase in gestational age, there is diminution of relative liver weight and this diminution is due to a real diminution in the proportion of true hepatic tissue present in the fetus [30,31,32]. In our present study also we observe that in the first half of pregnancy haemopoietic cells are abundant and reduced in amount during near term.

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Original Article

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Histochemical Characteristics of Mucosubstances in Diseased Breast

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Abstract

Background: The apical epithelial surfaces of mammalian respiratory, gastrointestinal, and reproductive tracts are coated by mucus, a mixture of water, ions, glycoproteins, proteins, and lipids. Mucins are mainly of two types- Neutral and Acidic. *Objectives:* To know the mucin distribution of the breast in malignant lesions. *Methodology:* This is a retrospective, observational , analytical, case control study aimed to evaluate mucinshisto-chemical pattern in malignant breast. Twenty five histologically proven malignant human breast tissue were taken. Tissue sections were stained by Mayer's Haematoxylin and Eosin, PAS, PAS-diastase, Phenylhydrazine-PAS, Alcian blue 2.5, Alcian Blue 1, combined alcian blue-PAS, Aldehyde Fuschin and combined aldehyde fuchsin-alcian blue techniques. *Results:* Results were tabulated according to color intensity into different grades ranging from + to ++++. Regarding mucin histochemistry of malignant breast - "sialomucins" were seen predominant than neutral and sulphomucins. *Conclusion:* Mucin histochemical patterns have valuable, cost-effective, and important role where a slight change in the mucin pattern may help in the early diagnosis of the disease process. Mucin histochemistry may provide a valuable and cost-effective tool for the diagnostic histopathology and for the researchers in histology.

Keywords: Mucosubstances; Special Stains; Breast Mucins; Carcinoma.

Introduction

Mucus is a complex viscous adherent secretion synthesized by specialized goblet cells in the columnar epithelium that lines all of the organs that are exposed to the external environment. This includes the respiratory tract, the gastrointestinal tract, the reproductive tract and the oculo-rhino-otolaryngeal tracts [1,2]. Mucus is composed primarily of water (95%), but also contains salts, lipids such as fatty acids, phospholipids and cholesterol, 1 proteins which serve a defensive purpose such as lysozyme, immunoglobulins, defensins, growth factors and trefoil factors. However, the main component that is responsible for its viscous and elastic gel-like properties is the glycoprotein mucin [1]. Mucins are high molecular weight glycoproteins that are found dispersed throughout the epithelia of the gastrointestinal, respiratory and reproductive tract [3]. The term mucosubstances is used, as recommended by Spicer, Leppi and Stoward (1965), to denote all tissue components other than glycogen, rich in carbohydrates,which are present in connective tissue or as secretion of certain epithelial structures [4]. Connective tissue mucosubstances are called "mucopolysaccharides", while those secreted by epithelia are referred as "mucins" [5]. Mucins are a family of high molecular weight, heavily glycosylated proteins (glycoconjugates) produced by epithelial tissues in most metazoans [6]. 'Mucins' key characteristic is their ability to form gels; therefore they are a key component in most gel-like secretions, serving functions from lubrication to cell signalling to forming chemical barriers. They often take an inhibitory role [6]. The function of mucins varies in part upon the tissue location of the mucin producing cell as well as the mucin type. In most cases, the secreted mucins provide lubrication and protection for the secreting cells in the immediate area. The function or role of the membrane bound mucins is not well understood. These mucins are likely involved in the regulation of cellular functions such as cell proliferation and cell adhesion [7]. Mucins perform a wide variety of functions like lubrication, protection against acids etc. The mucosubstances also contain immunoglobulins primarily of IgA type, lactoferrin

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which chelate the iron necessary for growth of some bacteria and lysosomes which destroy some of the bacteria. Hence they act as antibacterial and antiviral agents and have protective mechanism [8]. Mucins are classified into two main categories namely, Neutral mucins and acidic mucins.Neutral mucins are slightly alkaline in nature and mainly help for reducing the pH and toxicity of substances. They are first to appear during development in intrauterine life by fourth to fifth month. Acidic mucins are subclassified into weakly acidic and strongly acidic [9,10,11]. Weakly acidic mucins contain terminal carboxyl groups and are called as carboxylatedmucins or sialomucins. They contain chelating agents and have antibacterial and antiviral property. Strongly acidic mucins contain sulphate groups and are called as sulphomucins. They are thick, viscous and help for formation of protective coat for lubrication [10,11]. Histochemistry is defined as any technique in which a chemical reaction is involved in coloring tissue, be it staining with dyes or not. Thus more properly we have 'non-dye' histochemical technique and 'dye-involved' histochemical technique. The designation of a stain as special may be arbitrary, but generally any stain other than H and E is regarded as special stain. They are used in an attempt to identify cell and tissue components by virtue of their specific chemical reactions [11].

In malignancy, the malignant cells change their behavioural pattern and secrete different types of mucin than normal. During carcinomatous changes, cells revert back to their embryonic stage. Secretory changes occur even before the nuclear changes are visible and hence study of mucins may help to identify cancerous conditions at an early stage [12]. Thus early diagnosis even before carcinoma in situ will be of great clinical value in reducing the morbidity and mortality in the patients. Mucosubstancesof human mammary gland but few have studied about the mucinhistochemical characteristics in Intra Ductal Carcinoma using the stains used in present study.So the present study has been undertaken and correlated with previous workers [13-17].

Material and Methods

The present study was conducted in the Department of Anatomy, Krishna Institute of Medical Sciences, University, Karad from May 20014 to June 2017. The type of study was observational, analytical and case control study. Sample size was 30 blocks of each normal and carcinoma colon. The study was performed on 25 specimens of histologically proven infiltrating duct carcinoma of breast collected from postmortems and surgically removed specimen from Krishna Hospital Siddhivinayak Cancer Hospital, Miraj. The tissues were fixed in 10% formal saline with 2% calcium acetate and a pinch of phosphotungstic acid to help for preservation of mucins.

The tissues were embedded in paraffin and blocks were prepared byhistopathological technique and cut at 5-6 microns. Sections were stained with Hematoxylin and Eosin, and the following histochemical methods were performed on paraffin-embedded sections for the characterization of different mucosubstances as PAS, PAS diastase, PAS- Phenyl hydrazine, Alcian blue(AB) – pH 1and 2.5, Aldehyde fuchsin(AF), combined AB-PAS and combined AF-AB.

1. P.A.S.—Periodic acid Schiff reagent stains all carbohydrates including mucosubstances. Therefore mucosubstances are P.A.S. positive.
2. P.A.S. Diastase — Diastase dissolves glycogen like carbohydrates, but mucin remains unaffected.

This stain is used for confirmation of mucosubstances.

3. P.A.S. Phenyl hydrazine — Phenyl hydrazine dissolves neutral mucosubstances only and hence to prove their presence.
4. Alcian blue — This stain can be used at various pH levels.

a. AB pH 1 — This stain is highly acidic and stains sulphomucins only.

b. AB pH 2.5 — This stain is weakly acidic and stains both carboxylated and sulphomucins.

5. Aldehyde Fuchsin – This stain only stains sulphomucins and confirms their presence.
6. Combined AB-PAS – This staining procedure will stain all different types of mucin. Neutral –Magenta, Carboxylated –Blue, Sulphated —Purple.
7. Combined AF-AB — This staining procedure helps for differentiation and confirmation of carboxylated and sulphatedmucins.

Carboxylated –Blue, Sulphated—Purple

All the results obtained were tabulated according to color intensity into different grades ranging from + to ++++. [18,19,20].

1. ++++: Very strong positive reaction.

2. +++: Strong positive reaction.

3. ++ : Moderate reaction.
4. + : Weak reaction.
5. No staining: Negative reaction

Observation and Results

In the present study, H and E and special stains were used for mucinhistochemistry of 25 specimens of infiltrating duct carcinoma of breast.

Haematoxylin and Eosin was used to identify and confirm the diagnosis of carcinoma.

1. Sections studied show a tumor composed of cells arranged in diffuse sheets, well-defined nests, cords and as individual cells.

At places glandular differentiation is seen to be well developed while in other areas it is barely detectable or altogether absent.

The tumor cells are large and exhibit pleomorphism. Their nuclei and nucleoli are prominent. Numerous mitotic figures are seen.

Areas of necrosis are noted. Abundant stroma is seen and appears to be densely fibrotic to cellular.

A mononuclear inflammatory infiltrate of variable density is seen in the interphase between tumor and stroma (Figure 1).

2. PAS stain was used to asses presence of neutral mucosubstances. PAS stain gave mild reaction as focal magenta staining, suggestive of presence of few neutral mucosubstances (Figure 2).
3. PAS-diastase was used for confirmation of mucosubstances as diastase dissolves glycogen like carbohydrates but mucins remained unaffected. This gave mild to moderate reaction as magenta color confirming the presence of few PAS positive mucins (Figure 3)
4. PAS-Phenyl hydrazine was used to prove the presence of neutral mucosubstances as Phenyl hydrazine dissolves neutral mucosubstances only. PAS - Phenyl hydrazine gave mild to moderate reaction as magenta color confirms few neutral mucosubstances (Figure 4).
5. AB 2.5 pH gave mild reaction as blue colour . This is suggestive of presence of trace amont of acidic mucosubstances (Figure 5).
6. When stained with AB 1, To differentiate between the two, carboxylated (weakly acidic) and sulphated (strongly acidic) Alcian blue pH1 was carried out. AB-pH1 showed no reaction suggestive of no sulphatedmucins (Figure 6).
7. Aldehyde fuchsin stains only sulphomucins and confirms their presence . AF gave weak reactions as faint purple color suggestive of presence of few sulphatedmucins (Figure 7).
8. AB-PAS stain gave weak reaction as blue suggestive of trace amount of acidic mucosubstances. (Figure 8).
9. AF-AB technique helps to differentiate and confirm carboxylated and sulfated mucins. It gave strong reaction as blue and weak reaction as purple colour suggestive of predominance of carboxylated mucins and traces of sulphatedmucins (Figure 9).

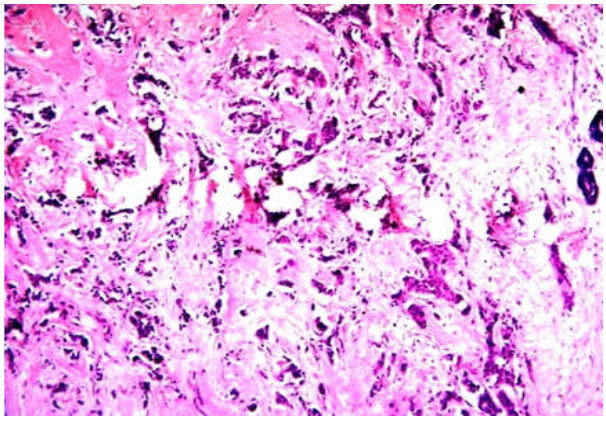

Fig. 1: Histology of Invasive Ductal Malignancy of Breast Photomicrograph 1 (H&E,10X)

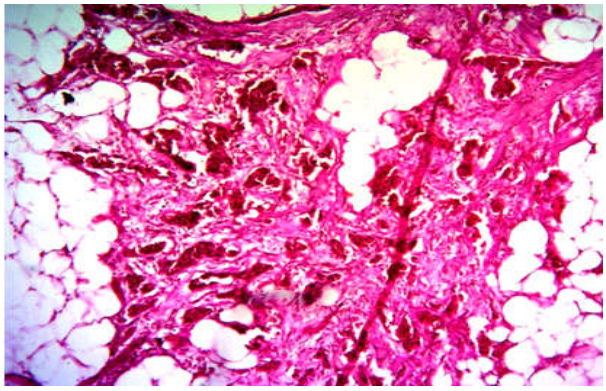

Fig. 2: PAS Photomicrograph 2 (H&E,10X)

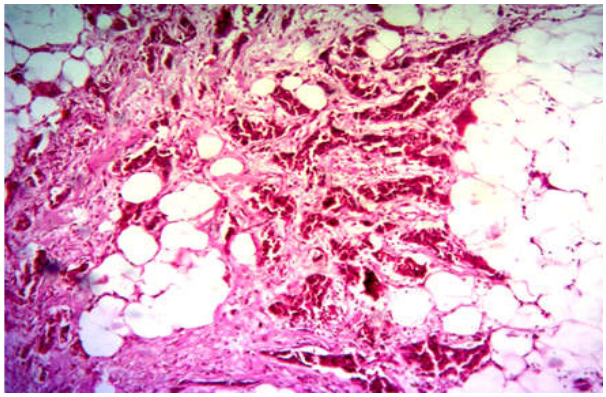

Fig. 3: PAS D Photomicrograph 3 (H&E,10X)

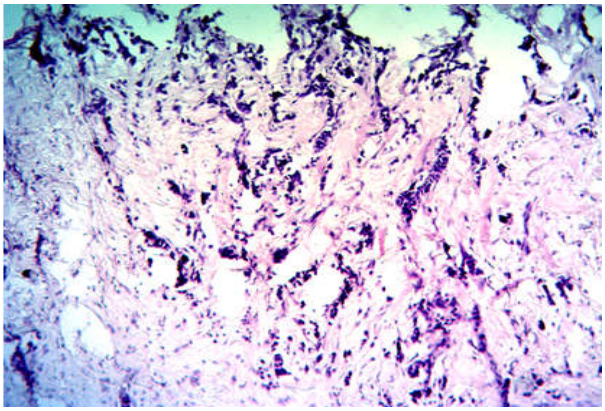

Fig. 4: PAS PH Photomicrograph 4 (H&E,10X)

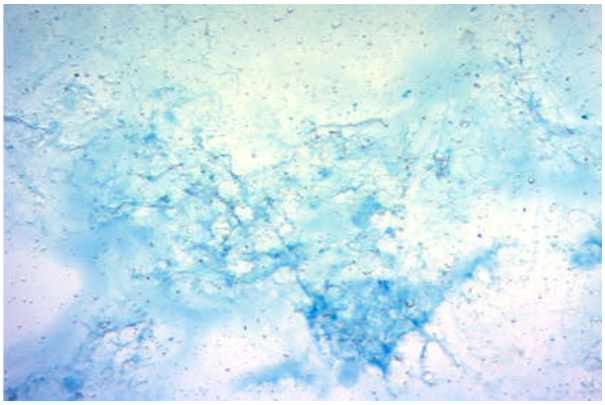

Fig. 5: AB 2.5 Photomicrograph 5 (H&E,10X)

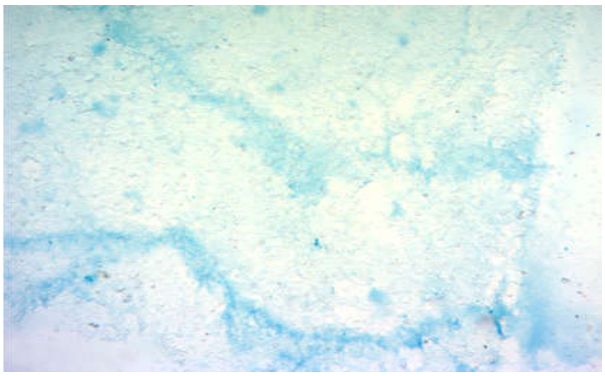

Fig. 6: AB 1 Photomicrograph 6 (H&E,10X)

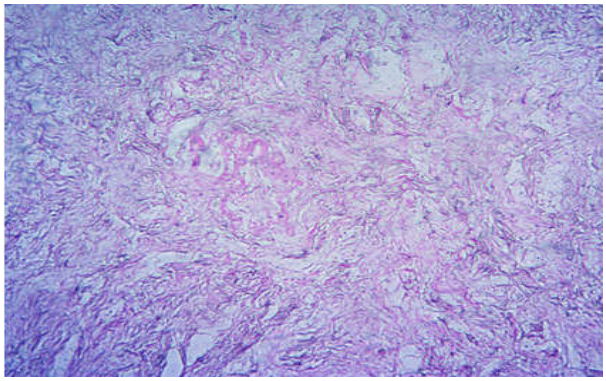

Fig. 7: AF Photomicrograph 7 (H&E,10X)

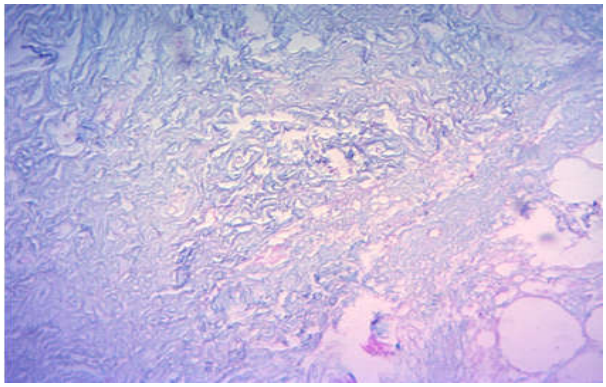

Fig. 8: AB PAS Photomicrograph 8 (H&E,10X)

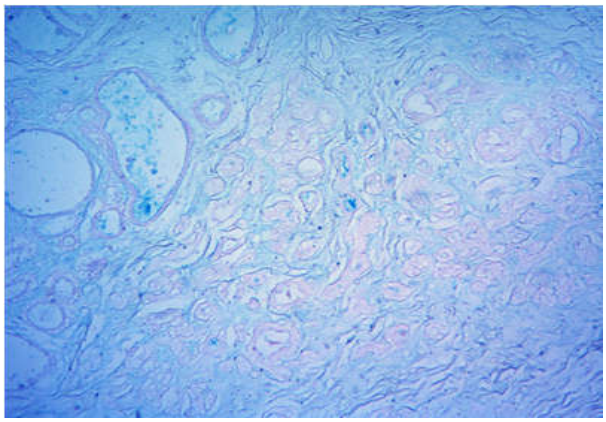

Fig. 9: AF AB Photomicrograph 9 (H&E,10X)

Table 1: Showing results of Mammary gland staining

No.	Stain	Intensity	Inference
1	H&E	-	Invasive Ductal carcinoma identified and confirmed.
2	PAS	++++	Presence of PAS positive substances i.e. carbohydrates and neutral mucins.
3	PAS-D	++	Presence of glycogen.
4	PAS-PH	+ / -	Presence of large amount of neutral mucins.
5	AB 2.5	+++	Presence of acidic mucins.
6	AB 1	+	Presence of sulfomucins in trace amount.
7	AF	+	Confirms presence of sulfomucins
8	AB–PAS	Magenta +++ Blue ++	Presence of neutral and acidicmucins.
9	AF-AB	Blue ++ Purple +	Confirms presence of sialomucins with trace amounts of sulfomucins.

Regarding mucinhistochemistry of infiltrating Duct Carcinoma of Breast, "mixture of mucosubstances" were observed, "carboxylated acidic mucins" were seen predominantly than neutral and sulphated acidic mucins.

Discussion

Mucin is a high molecular weight glycoprotein that is synthesized, stored and secreted by connective tissue and epithelial mucosal cells, especially the goblet cells [23]. In normal tissues, mucins seem to exhibit tissue- and cell-specific histochemistry patterns of expression.

The patterns of distribution exhibited might be quite complex, with several different mucins often expressed in the same organ and at times the same cell [24]. However, under pathologic conditions this distinct expression patterns are modified. Numerous types of mucin occur depending on the site of production. Examples of connective tissue mucins are chondroitin sulphate, heparin sulphate, keratansulphate, and hyaluronic acid. Epithelial mucins may be acid or neutral. Neutral mucins are hexosamine units without free acidic groups. Acid mucins consist of hexosamine unitswhich may be associated with glucuronic or sialic acid, the reactive group being a carboxyl. In sulphatedmucins this group is blocked by a sulphategroup which becomes the active group. Strongly sulphatedmucins are of connective tissue type; the weakly sulphated groups are of epithelial type. The non-sulphatedmucinsare sialic acid and hyaluronic acid (carboxylated D-glucuronic acid). These can be enzymatically digested, though enzyme-resistant forms do occur.The presence of carboxyl groups or sulphate groups was determined by the various staining techniques described and confirmed using enzymedigestion methods. Until relatively recently the type of mucin in mucous carcinoma of the breast has remained in doubt. It is of interest that Lange (1896) [25], who stained his sections with toluidine blue, concluded that the mucin was of connective tissue origin. However, Gaabe (1908) [26] using the same stain concluded that the mucin was of epithelial origin, a theory propounded by Virchow (quoted by Lee, Hauser, and Pack, 1934) [27]. Ewing (1922) [28] favoured a dual origin from both connective tissue and epithelium but also in some cases from fat. The first histochemicalstudy performed in order to ascertain the type of mucin was by Grishman (1952) [29] who demonstrated its epithelial origin. Since then many histochemicalstudies of mucous carcinoma of the breast have appeared in the North American literature. Norris and Taylor (1965) [30] found the mucin to be a poorly sulphated mucopolysaccharide, though Spicer,Neubeeker, Warren, and Henson (1962)[31]had shown this to be enzymatically digestible sialic acid. The present study has confirmed the presence of sialomucin, but abundant neutral mucin has also been demonstrated. The acid mucin was of carboxylated type which is the most commonly encountered type in IDC breast. This study is in accordance with the above mentioned worker. Occasionally a mammary carcinoma may show marked mucin production within the stroma. However, apart from the different histochemistry of stromal mucin, the histological appearances are distinct from that of a mucous carcinoma.

Conclusion

The Invasive Ductal Carcinoma showed the presence of neutral mucins and acidic mucins.In acidic mucinssialomucins were present and sulfomucins were recorded in trace amounts. Any change in the mucin pattern may be helpful in the early diagnosis of any disease process.

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Original Article

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Study of Axillary Arch: Embryological Basis and Its Clinical Implications

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Abstract

Aim: To study the incidence, embryological basis and clinical implications of unusual but most common anatomical variant, axillary arch. *Materials & Methods:* The study was conducted in the department of Anatomy, Subbaiah Institute of Medical Sciences, Shimoga during routine cadaveric dissection on 60 upper limbs. *Results:* Of the 60 upper limbs dissected, Axillary arch was seen in one right upper limb. It was extending between latissimus dorsi and fascia covering the subscapularis muscle after crossing the posterior cord of brachial plexus and circumflex scapular vessels. It was supplied by a branch from the thoracodorsal nerve. *Conclusion:* The presence of an axillary arch needs to be considered in differential diagnosis of axillary swellings and also in surgeries of shoulder region. Therefore it is mandatory to know the variant slips of the musculotendinous arch.

Keywords: Axillary Arch; Latissimus Dorsi; Neurovascular Bundle; Clinical Implications.

Introduction

The axillary arch muscle is an accessory muscle that extends between the pectoralis major and latissimus dorsi [1]. It is a variant muscular slip of the pectoralis major muscle and is about 7 to 10 cm in length and 5 15 mm in breadth, crossing from the edge of latissimus dorsi, midway in the posterior fold, over the front of the axillary vessels and nerves to join the tendon of pectoralis major, coracobrachialis or fascia over the biceps [2]. The axillary arch muscle develops embryologically from the pectoral muscle mass. It is hence generally innervated by the medial pectoral nerves [3]. However, because of its close relationship with the latissimus dorsi, it may receive nerve supply from the thoracodorsal nerve [4]. It can also receive nerve fibers from the lateral pectoral nerve and intercostobrachial nerve [5].The most commonly described form of this muscle extends from latissimus dorsi to pectoralis major, the short head of biceps brachii or to the coracoid process of the scapula. Many other variants of this anomaly have also been observed like the muscle adhering to the coracoid process of the scapula, medial epicondyle of the Humerus or blending with the fibers of teres major, long head of triceps brachii, coracobrachialis and pectoralis minor [6]. Its embryonic origin is not clear and some anatomists consider muscular arches of the axilla as rudimentary phylogenetic remnants of the panniculus carnosus [7]primarily, the axilla contains the diverging elements derived from the brachial plexus and axillary vessels [1]. This arch is an atavistic anomaly in the axillary region and is also described by few authors as chondro-epitrochlearis when it extends from the pectoralis major muscle to the medial epicondyle [8].

Various terminologies are used to describe this variant structure as "Achselbogen", "axillopectoral muscle", "axillary arch", "Langer's axillary arch" or "muscular axillary arch" [5]. Nowadays, the term "Langer's axillary arch", first coined by Testut in 1884, describes any muscular anatomical variant running from the lateral border of latissimus dorsi to various points anterolateral to the humerus. Historically, the axillary arch was first described in 1783 by Bugnone, then again by Ramsay in 1793 and then finally by Langer in 1846 [5]. It should be noted, however, that both arches mentioned by Bugnone and Ramsay were muscular in nature, while Langer specifically mentions a fibrous variant, suggesting that Langer's axillary arch can have various degrees

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of muscularisation and is not simply either muscle or fibrous [9]. However, the muscle has been named after Langer who gave the first description of the muscle in 1846 [10]. The incidence of axillary arch muscle reported in different population groups as 7% in Japanese, 10% in Belgian, 0.25% in British Population [11].

Knowledge of muscular, vascular, and neural variations in the axillary region is of clinical importance in mastectomies, breast reconstruction, and axillary bypass operations [12]. The axillary arch can cause thoracic outlet syndrome and shoulder instability. Entrapment of the neurovascular bundle within the arch can lead to entrapment syndrome. In addition, the axillary arch hides a small group of lateral axillary nodes, which can mislead the surgeon during breast surgery [13].

Materials and Methods

The study was conducted in the department of Anatomy, Subbaiah Institute of Medical Sciences, Shimoga during routine cadaveric dissection on 60 upper limbs, irrespective of age and sex.

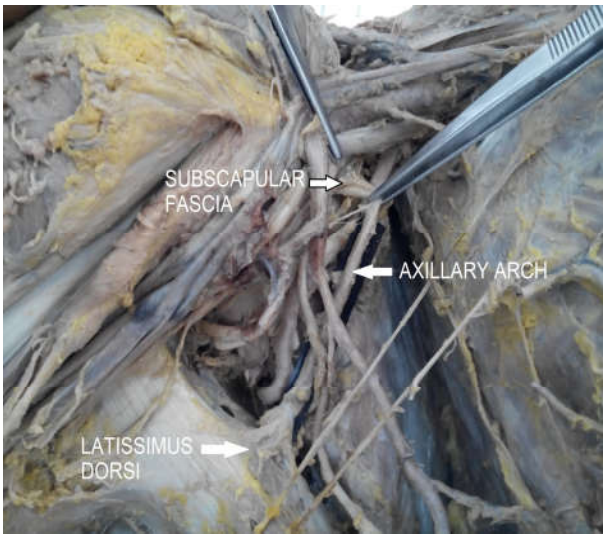

Fig. 1: Axillary arch showing its attachment

Results

Of the 60 upper limbs dissected, Axillary arch was seen in one right upper limb. It was extending between latissimus dorsi and fascia covering the subscapularis muscle after crossing the posterior cord of brachial plexus and circumflex scapular vessels. It was supplied by a branch from the thoracodorsal nerve.

The incidence of axillary arch in our study was 1.66% and this was compared with other studies as shown in Table 1.

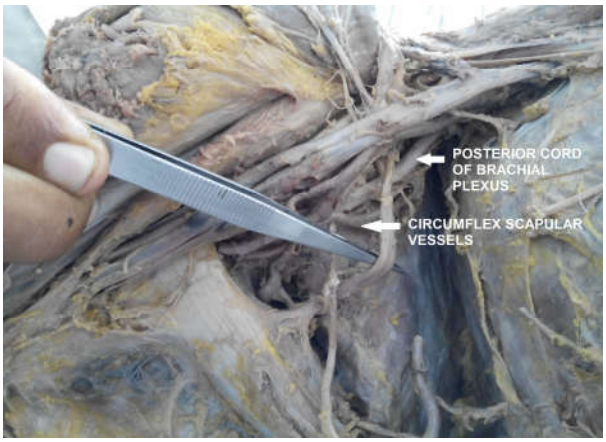

Fig. 2: Structures crossed by axillary arch

Fig. 3: Axillary arch with its nerve supply

Table 1: The incidence of the axillary arch muscle in different population

Author	Year	No. of arches	No. of upper limbs	Percentage	Population
Serpell and Baum [14]	1991	4	2000	0.2	Caucasian
Clarys et al [23]	1996	16	183	8.7	Caucasian
Turgut et al [24]	2005	1	26	3.8	Caucasian
Pai MM [11]	2006	1	68	1.47	Indian
Vaishaly K et.al [25]	2013	1	30	3.33	Indian
Bharambe and Arole [28]	2017	1	30	3.33	Indian
Present study	2018	1	60	1.66	Indian

Discussion

Axilla is a fascial lined pyramidal tent shaped portal for transmitting the neurovascular bundle between upper limb and neck and also contains the axillary group of lymph nodes which are of clinical and surgical importance.

A muscular variant known as the 'Axillary arch of Langer' is a musculo-tendinous slip observed in the axilla stretching across the neurovascular bundle. When present, the classical variant extends from the lower border of latissimus dorsi to the trilaminar tendinous insertion of pectoralis major muscle [14].

The next most common variant described by Dovernoy, is the Chondro-epitrochlearis, a musculo-tendinous arch that extends from pectoralis major to medial epicondyle [15]. Landry SO Jr also described chondro-epitrochlearis muscle which bifurcated into two slips, with the upper slip inserted into the capsule of the shoulder joint close to the origin of long head of biceps and the lower slip into the medial epicondyle [8].

Dharap in 1993 described an axillary arch which was unusually extending from the lower border of latissimus dorsi muscle to the coracoid process of the scapula. He also observed several accessory slips wherein three fibrous strands extended from the arch to the pectoralis minor, short head of biceps and coracobrachialis, two muscular slips to the deep surface of teres major muscle and innumerable accessory muscular slips arising from the ribs and costal cartilages [16].

Lin C reported an interesting case of bilateral chondro-epitrochlearis muscle with contracture, restricting abduction of arm in a seventeen year old Chinese boy [17].

A unique case was reported by Lama P et. al., where both the 'Axillary arch of Langer' and the 'chondroepitrochlearis' were observed in the same axilla. The 'Axillary arch of Langer' originated from the lattisimus dorsi muscle, while the 'chondro-epitrochlearis' originated from the pectoralis major muscle and both the muscular slips crossed over the axillary neurovascular bundle and had a common insertion into the lateral lip of inter-tubercular sulcus of the humerus and the fascia covering the biceps brachi muscle [18].

In general population, the frequency of axillary arch is reported as 4–12%; however, this ûgure is predominantly based on results from cadaveric studies. About 0.25% to 6.5% of incidence is reported in clinical studies [19]. The incidence of axillary arch muscle reported in different population groups as 7% in Japanese, 10% in Belgian, 0.25% in British Population [11]. The differences in population frequency of the axillary arch are probably related to differences based on genetics [20].

Regarding the possible genesis of this muscular arch, various theories are proposed. In lower mammals the panniculus carnosus is very well developed to form the pectoral group of muscles. With evolution these muscles have regressed due to reduced functional importance [21]. In 1980 bilateral axillary arch muscle was reported in a case of Trisomy 13 indicating a possible genetic basis [22].

In the present study, out of 60 upper limbs, Axillary arch was seen in one right upper limb, the incidence being 1.66%. It was extending between latissimus dorsi and fascia covering the subscapularis muscle after crossing the posterior cord of brachial plexus and circumflex scapular vessels. It was supplied by a branch from the thoracodorsal nerve.

Our study was compared with the study of axillary arch by L. Jelev et. al [5] who has provided a classification depending on the situation of the axillary arch in relation to the neurovascular bundle. According to the author, two groups are explained, superficial being the classical variant wherein the arch crossing the entire neurovascular bundle and deep group wherein the arch usually crosses only parts of neurovascular bundle. Our finding belonged to the deep group, where the axillary and radial nerves could possibly be compressed.

Axilla is a region of hyper dynamic blood flow and muscular or fibrous slips when present, passes across the neurovascular bundle thus compressing these structures leading to stasis of blood and resulting in axillary vein thrombosis and subsequent thromboembolism, nerve compression, hyper-abduction syndrome, arterial occlusion and edema of lymphatics [26].

An axillary arch can compress upon the lateral axillary lymphatics and restrict their removal during axillary surgeries for breast cancer thus increasing the risk of recurrence of carcinoma [13]. Breast reconstruction surgeries involve the use of latissimus dorsi myocutaneous flaps and once the flap is raised the pedicle is rotated and presence of a musculo-tendinous arch in such cases can result in axillary vein entrapment syndromes resulting in postoperative lymphoedema of the upper limb [27].

In axillary surgeries the incision is given along the anterior margin of Latssimus dorsi but in the presence of a musculo-tendinous arch, the surgeon maybe under confusion regarding the placement

of the incision. This may lead to an incision above the axillary vein causing damage to the axillary sheath as a level below the vein is usually more favorable in presence of axillary arch [14]. Surgical excision of the arch in cases of axillary contractures is suggested followed by physiotherapy to prevent scarring [17].

Conclusion

The presence of an axillary arch needs to be considered in differential diagnosis of axillary swellings such as lipomas, ectopic breast tissue, inflammatory axillary lymph nodes, infundibular follicular cyst, nodular fibromatosis and metastatic deposits in the axillary lymph nodes. The possibility of attachment of a slip of the axillary arch to the capsule of shoulder joint should be kept in mind during shoulder joint surgeries. A myocutaneous flap of latissimus dorsi is used in breast reconstructive surgeries and to cover large soft tissue defects in head and neck region.

Clinical detection of this muscle is difficult; however, it is possible to detect the presence of the axillary arch on performing computed tomography scan or magnetic resonance imaging of the axillary region. Therefore knowing the exact extent, attachment and innervation of this muscle becomes mandatory.

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Original Article

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Correlation of Hand Length and Height in the Residents of Kerala and Estimation of Height from Hand Length using Regression Equation

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Abstract

Introduction: Height is one of the important factor serving as a parameter for personal identification. In natural calamities or mass explosions or fights where body parts are available it becomes important to know factors which can help in the identification of the individuals. There are several factors like race, ethnicity, nutritional status that influence the growth and development of the individual so there should be different methods and ways to be applied for identification for different population [1]. When only the segments of the bodies are available to determine the height from them becomes important to a forensic personal for identification and analysis. So estimating the height of the individual from the different body remains is utmost important as it provides this forensic anthropological value [2,3]. In this study the correlation of the height with hand length is done in thestudents and some volunteers in Kerala in the age group of 18 to 25. *Aim:* To study the correlation between hand length and height and to derive the equation for calculating the height from the hand length. *Methodology:* The study was conducted by taking 133 comprising of 73 girls and 60 boys ranging in the age group of 18-25 years. The medical students of first year and second year M.B.B.S were selected for the study. The subjects who were apparently normal with no obvious musculoskeletal deformities were included in the study. The height and hand length measurements were taken. The parameters were then analyzed and correlation study was done and statistical significance was studied. The regression equation is calculated for the height. *Results:* The study showed that was significant correlation between right hand length and height. Pearson's correlation analysis was used and it showed a positive correlation between hand length and height. Regression equation was derived using S.P.S.S. software to calculate the height of the individual from hand length *Conclusion:* There is a positive correlation between hand length and height. It is sought as the height and hand length is directly proportional. The height is nearly nine times the length of the hand.

Keywords: Height; Females; Males; Kerala; Hand Length.

Introduction

The Height is an important aspect of human personality. It forms an essential component of a personal identification. The total stature of the human body is sum of length of certain bones and appendages of the body. And there is a certain relationship of the body segments with the proportion of the height of the individual [4]. Height is determined by various factors like nutrition, genes, and environmental factors. Height is also affected by the race of the population. There are several occasion which lead to mass disasters like earthquakes, tsunamis, manmade disasters like wars or even murders, suicides where we find the identification of bodies and different body segments a serious challenge [5]. Now where there is major loss of facial identification or even when only body parts like hands, legs available height of the individual forms an important parameter in identification. Soheight is aimportant key to physical anthropology and forensic science [6].

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The reliability of prediction of height from foot length is as high as from long bones [7]. So establishing height from various parameters in different population has importance as same formulas and standards don't stand accurate in different population and regions [8,9]. The Identification of individual remains significant for stature reconstruction for which foot length and hand length are used as a predictor of height [10].

The hand length was found to be the most reliable alternative that can be used as a basis for estimating age related loss in height. Hand length is also the good predictor of the body surface area independent of the sex of the individual according to the study done by Amirsheybani et al. (2000)[11].

The aim of this study is to determine the correlation between the hand length and height and estimation of the height from the hand length in Kerala region.

Materials and Methods

A sample of 133 individuals which had 73 girls and 60 boys in the age group of 18–30 years is included in this study. These individuals belong to Kerala origin. Those with congenital musculoskeletal abnormalities and those who had previous fractures were excluded from the study. And Informed consent was taken from these participants. The following particulars were noted: Age, Height and Right and Left hand lengths. The height of the subjects was taken with the standing erect anatomical position and noted in centimeters. The height being measured from the highest point of the skull vertex to heel. [12,13].

The hand lengths taken by following method.

Each subject was asked 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. 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 was drawn joining the two styloid tips.

The Interstyloid distance was marked on the hand and its midpoint was marked. The length of the hand was measured from the midpoint of previous line to the tip of middle finger using a ruler scale. The measurements were recorded in centimeters to the nearest 0.1 cm. [11]

Both Right hand length and left hand lengths was taken.

These measurements were taken at fixed time to eliminate diurnal variation and by the same person to avoid observer error.

Results

In the present study there are a total of 133 subjects of which there are 60 males and 73 females.

Height and hand length characteristics of subjects

In the present study, it shows that mean height of male medical students was 172.9267± 7.4 and female medical students was 160.33±7.15. Mean length of right hand in male medical students was 20.05cms ±1.04cm. and female medical students was 18.26±0.96cm.

Table 1: Showing the total number or male and female subjects and their mean ages

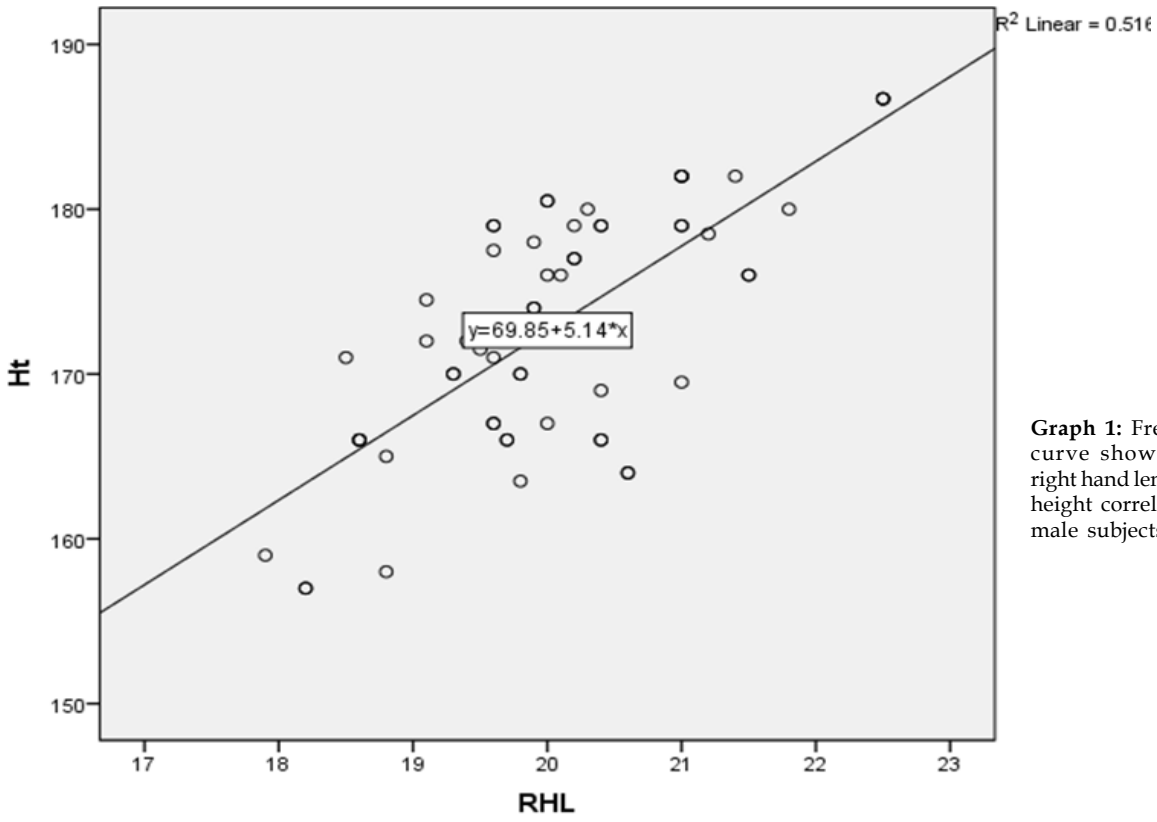
	Males	Females
Total number	60	73
Manage	20.68 ± 1.58	21.68 ± 3.78

Table 2: Showing the Height and measurements of the hand length in males, the multiplication factors for estimating height from the hand length measurements and correlation of these measurements with stature

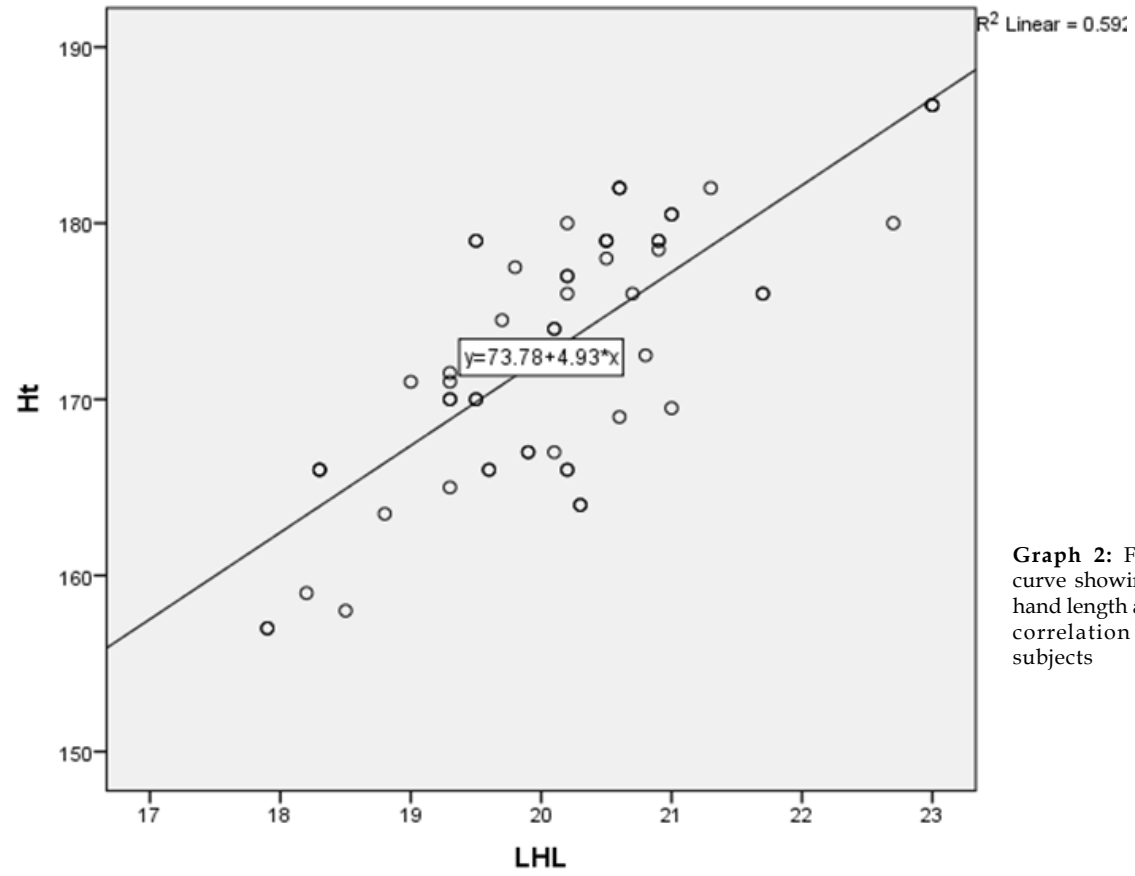
Variable	Mean ± SD	Mean multiplication factor	Correlation of hand lengths with height	
			r value	p value
Mean height	172.93 ± 7.45			
Right hand length	20.06 ± 1.04	8.62	0.71	<0.0001
Left hand length	20.13 ± 1.16	8.59	0.77	<0.0001

Table 3: Showing the Height and measurements of the hand lengt in females, the multiplication factors for estimating height from the hand length measurements and correlation of these measurements with stature.

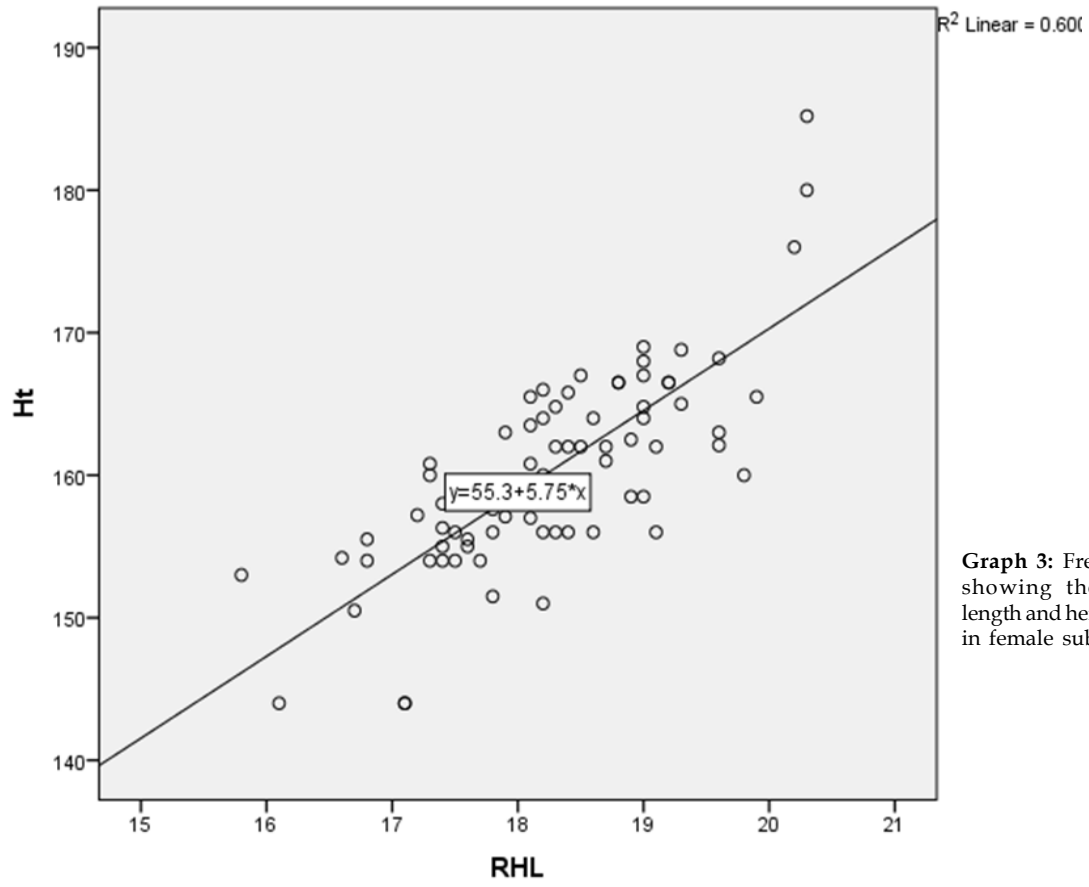
Variable	Mean ± SD	Mean multiplication factor	Correlation of hand lengths with height	
			r value	p value
Mean height	160.33 ± 7.16			
Right hand length	18.27 ± 0.96	8.78	0.77	<0.0001
Left hand length	18.20 ± 0.96	8.81	0.73	<0.0001



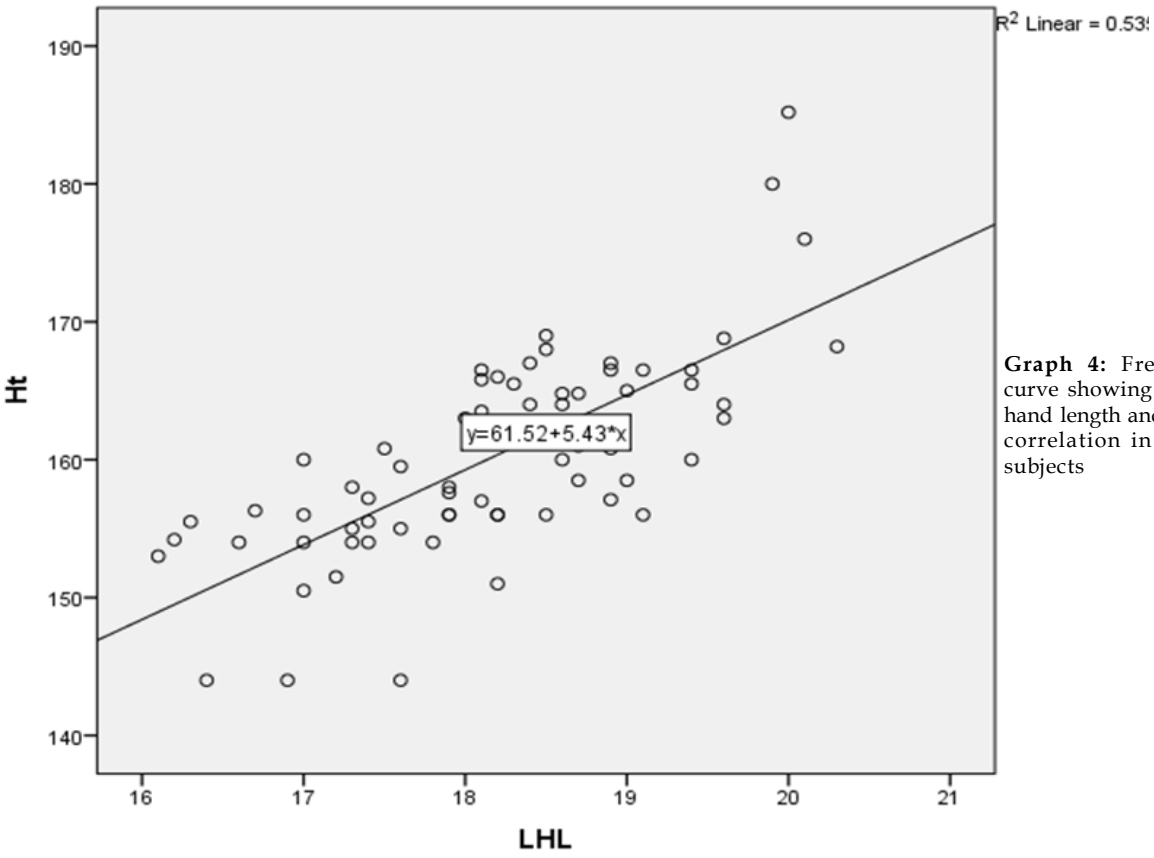
Graph 1: Frequency curve showing the right hand length and height correlation in male subjects



Graph 2: Frequency curve showing the left hand length and height correlation in male subjects



Graph 3: Frequency curve showing the right hand length and height correlation in female subjects



Graph 4: Frequency curve showing the left hand length and height correlation in female subjects

In our study age group the height is approximately 9 timesmore than length of hand. Pearson's correlation analysis was used to and shows a strong positive correlation, which means that high X variable scores go with high Y variable scores.

It has been shown in this study that there was a significant correlation between height and hand length. As there is increase in the hand lengt, height also increases in a proportional manner.

Linear regression equation was derived for estimation of height in males from hand length and similarly the estimation of height from hand length was derived for females.

The p value ($P< 0.001$) showed positive correlation between height and hand length.

Results in Male Subjects

The regression equation derived for calculating height is as follows;

In Males

Height designated as "y" and the hand length as "x"

The height is derived as for Right hand as

$Y= a x + b$

a= constant and b = constant

so $y=(5.139) x + 69.852$

and for left hand $y=(4.93) x + 73.78$

Results in Female subjects

The regression equation derived for calculating height is as follows;

Height designated as "y" and the hand length as"x"

For Right hand length the Height is derived as

$Y= a x + b$

a= constant and b = constant

so $y=(5.75) x + 55.30$

For Left hand length the Height is derived as

so $y=(5.43) x + 61.52$

Discussion

The present study is mainly done to co relate the height and hand length. As per the statistics it showed that there is a strong positive correlation between height and hand length both in males and females.

Height can be derived using the regression equation which can be useful for identifying the body by the forensic scientist in cases where only fragments of limbs or hands available. These predictions of height are also of significance to artificial limbs providers in people whose lower limbs are amputed. Since long it has been established that height can be derived from long bones of the body and so hand length serves also the same purpose [14].

Estimation of height using various physical measurements has been attempted by many researchers but the one variable that proves to be consistently reliable in the estimation of height is the hand length [15,16]. Similarly study was done to determine height from the length of clavicle [17]. There was a study showing significant correlation between foot length and the height by Charnalia in 1961[18]. Shroff and Vare derived height from length of superior extremity and its segments [19]. Similarly a regression equation is derived by Saxena et al between hand length and height. The result from the present study shows that hand length can be used to predict height. The present study shows the parameters used to determine height can also be used to determine hand length because there was a 2-tailed significant correlation between hand length and height.

There is a study done on Nigerian population and in North Indian population showing similar results [20]. Study of height from hand in Punjabi males was done [21]. In the age group of the present study the height in males from right hand is 8.62 times and 8.59 times more than length of hand. In the age group of the present study the height in males from right hand is 8.78 times and 8.81 times more than length of hand. This shows that height in males and female of any age group is nearly 9 times more than the length of hand.

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A Morphometric Study of Carrying Angle in Garhwal Region of Uttarakhand

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Abstract

Context: The Carrying angle is defined as the angle between the median axis of arm and that of fully extended and supinated forearm. It is generally greater in females than in males and ranges from 2°-21° in males and 2°-26° in females. The Carrying angle also shows variation with age and various anthropometric parameters. Racial and regional influences add further to its variability. Thus, knowledge of carrying angle is useful for Orthopaedicians in their clinical practice,Biomechanical engineers for preparing elbow implants, Forensic experts and Anthropologists during prediction of sex and race of an individual. *Aims:* To determine the normal Carrying angle of individuals belonging to Garhwal region of Uttarakhand and to compare these values with those reported by other authors in different ethnic groups. *Materials & Methods:* A cross sectional study was conducted among 400 healthy individuals of both sexes of age group 18–40 years of Garhwal region of Uttarakhand using Goniometer and the data was analysed statistically. *Results:* The mean right Carrying angle was found to be 8.71°±2.54° in males and 12.31°±2.53° in females. The mean left Carrying angle was found to be 8.06°±2.77° in males and 11.76°±2.73° in females.The values are significantly different from those reported by other authors in different ethnic groups. *Conclusions:* This study has established data on the Carrying angle of Garhwal population of Uttarakhand. The carrying angle shows wide regional and racial variations.

Keywords: Carrying Angle; Elbow; Goniometer.

Introduction

The Carrying angle is defined as the angle formed by the long axis of arm and the long axis of forearm in the frontal plane, when the elbow is fully extended and the forearm is fully supinated [1]. The external angle formed between the long axis of arm and forearm is an obtuse angle [2], which is normally 175° in males and 165° in females [3]. Whereas the internal angle formed between the arm and forearm is an acute angle. This angle is usually greater in females than in males [4] and the difference has been considered to be a secondary sexual characteristic [5]. It ranges from 2°-21° in males and 2°-26° in females [6].

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The level of the elbow joint is situated 2 cm below a line joining the two epicondyles. It slopes downwards and medially from its lateral extremity, and this obliquity produces the Carrying angle. The angle is also caused partly by the projection of the medial trochlear edge about 6 mm beyond its lateral edge and partly by the obliquity of the superior articular surface of the coronoid process of ulna, which is not orthogonal to the shaft of ulna [3].

The angle is usually greater in the dominant limb than in the non-dominant limb of both sexes, suggesting that the natural forces acting on the elbow modify the Carrying angle [7]. It is inversely proportional to the height of a person and length of forearm [8]. It also shows a direct relationship with the width of pelvis [9]. Development, ageing and racial influences add further to the variability of the Carrying angle [7]. It also shows wide regional variations, which might be due to effect of environmental and genetic factors during growth and development of an individual [10].

Increased Carrying angle may lead to elbow instability and pain during exercise [11]. It may predispose to dislocations [12] and increase chances of fracture around elbow when falling on an

outstretched hand. The type of fracture a child sustains is determined by the value of Carrying angle [4]. Sometimes after healing of certain fractures of elbow, the Carrying angle may increase or decrease abnormally, i.e. Cubitus valgus or Cubitusvarus respectively [13]. A case of Cubitus valgus may lead to gradual stretch of ulnar nerve behind the medial epicondyle and may cause ulnar nerve palsy [14].

Thus, the knowledge of Carrying angle is useful for Orthopaedicians in their clinical practice for management of various elbow disorders, like-fractures, dislocations and in elbow reconstructions [15], for Biomechanical engineers for preparing elbow replacement implants [11] and for Forensic experts and Anthropologists during prediction of sex and race of an individual especially in fragmentary skeletal remains [16].

So, this study was conducted to determine the range of normal values of Carrying angle of individuals belonging to Garhwal region of Uttarakhand, and to compare these values with those reported by other authors in their studies done in different ethnic groups.

Materials and Methods

A cross-sectional study [8] was conducted among healthy individuals of both sexes of age group 18-40 years belonging to Garhwal region of Uttarakhand. A total of 400 individuals were selected using Stratified random sampling method [17].

The age range was selected to minimise the confounding factor where Carrying angle has been documented to alter with age [14]. Individuals with clinical evidence of any trauma, disease condition, or undergone any surgery involving upper limb were excluded from the study.

The study was approved by the College Ethics Committee, in accordance with the International ethical standards. Informed, written, witnessed consent in vernacular of each participant was taken prior to their examination.

A full circle universal manual metallic protractor Goniometer was used to measure the elbow Carrying angle of individuals [17]. The subjects were asked to stand in anatomical position on a flat ground. The hinged Goniometer has two arms- fixed arm and mobile arm, the two joined at a hinge. The hinge was placed on the volar aspect of elbow joint of the individual, in midline about 2cm below a line joining the medial and lateral epicondyles. The fixed arm was aligned with the median axis of arm and the mobile arm aligned at first in straight line with the fixed arm. Then the mobile arm was re-adjusted to align with the median axis of forearm. Bicipital groove, biceps brachi tendon at its insertion and palmaris longus tendon at the wrist were used to demarcate the median axis of arm and forearm [8]. An angle was formed between the two axis on the medial aspect of elbow [4], which was read out as the Carrying angle. Measurements were made in degrees and taken on both upper limbs. Each side was measured three times, average of the three readings calculated and rounded off to the nearest whole number.

Statistical Package for Social Sciences 17 [SPSS 17] and Smith's Statistical Package [SSP] were used for data analysis. Independent sample t-test was used to compare the mean values among various groups. A p-value<0.05 was considered significant and p-value<0.01 highly significant.

Results

Mean right Carrying angle [RCA] and Mean left Carrying angle [LCA] of males and females are shown in Table 1.

Discussion

In this study, the mean right Carrying angle was found to be 8.71°±2.54° in males and 12.31°±2.53° in females. The mean left Carrying angle was found to be 8.06°±2.77° in males and 11.76°±2.73° in females.

Similar values of Carrying angle in females were found in the studies conducted by Terra BB et al. [18], Ruparelia S et al. [8] and Zampagni ML et al.[19].

Table 1: Mean Carrying angle

Angle	Males [n-201]	Females [n-199]
RCA	8.71°±2.54°	12.31°±2.53°
LCA	8.06°±2.77°	11.76°±2.73°

RCA: Right Carrying Angle,LCA: Left Carrying Angle,n: Number

The results of the present study were compared with those reported by other authors in different ethnic groups of India [Table 2, Graph 1] and world [Table 3, Graph 2].

Table 2: Comparison of Carrying angle of both males and females found in this study with those reported by other authors in different ethnic groups of India

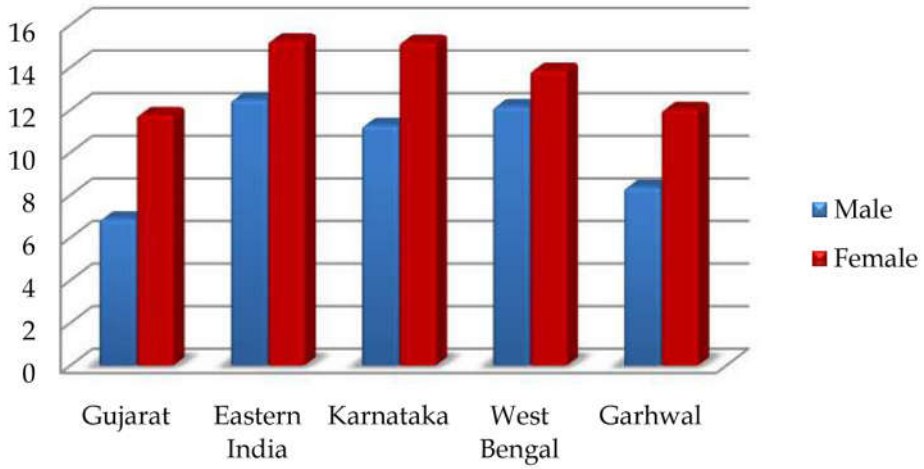
S. No.	Author	Male n	Male Mean ± SD [degree]	p-value	Female n	Female Mean ± SD [degree]	p-value
1.	Ruparelia S et al.[8] [Gujarat]	160	6.9±1.25	p<0.01	173	11.8±2.27	p>0.05
2.	Dey S et al.[20] [Eastern India]	180	12.5±0.57	p<0.01	180	15.26±0.45	p<0.01
3.	Mangalur V et al.[21] [Karnataka]	60	11.29±1.46	p<0.01	80	15.20±0.71	p<0.01
4.	Bari W et al.[22] [West Bengal]	200	12.18±2.62	p<0.01	200	13.88±3.46	p<0.01
5.	Present study [Garhwal]	201	R-8.71±2.54 L-8.06±2.77		199	R-12.31±2.53 L-11.76±2.73	

n: Number,SD: Standard deviation,R: Right, L: Left

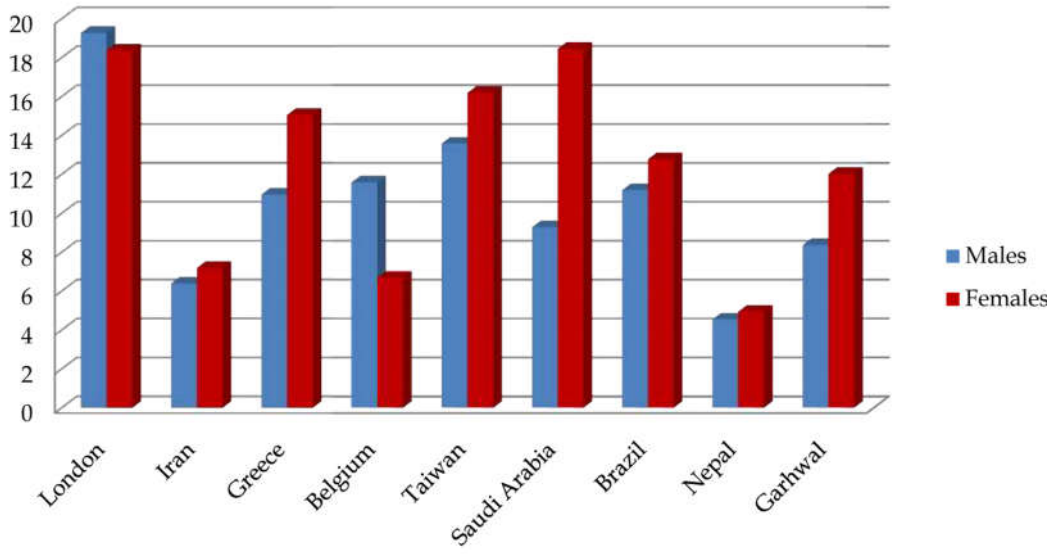
Table 3: Comparison of Carrying angle of both males and females found in this study with those reported by other authors in different ethnic groups of world

S. No.	Author	Male n	Male Mean ± SD [degree]	p-value	Female n	Female Mean ± SD [degree]	p-value
1.	Steel FLD et al.[23] [London]	50	19.28±4.67	p<0.01	50	18.38±8.41	p<0.01
2.	Emami MJ et al.[24] [Iran]	1726	6.4±1.73	p<0.01	2540	7.2±1.99	p<0.01
3.	Paraskevas G et al.[25] [Greece]	320	10.97±4.27	p<0.01	280	15.07±4.95	p<0.01
4.	Roy PV et al.[26] [Belgium]	10	11.6±3.2	p<0.01	10	16.7±2.6	p<0.01
5.	Chang CW et al.[27] [Taiwan]	13	13.6±3.0	p<0.01	23	16.2±3.2	p<0.01
6.	Alsubael MO et al.[28] [Saudi Arabia]	45	9.29±2.98	p<0.01	45	18.47±4.12	p<0.01
7.	Park S et al.[29] [Seoul]	15	14.9±2.60 [X-ray]	p<0.01	10	18.3±4.38 [X-ray]	p<0.01
8.	Terra BB et al.[18] [Brazil]	255	11.20±4.45	p<0.01	255	12.79±5.35	p>0.05
9.	Eliakaim- -Ikechukwu C et al.[30] [Nigeria]	170	R-17.63±0.25	p<0.01	129	R-18.67±0.35	p<0.01
		Ibo	L-15.05±0.24	p<0.01	Ibo	L-16.64±0.33	p<0.01
		105	R-15.35±0.35	p<0.01	100	R-17.57±0.39	p<0.01
		Yoruba	L-13.25±0.35	p<0.01	Yoruba	L-15.55±0.37	p<0.01
10.	Sharma K et al.[31] [Nepal]	335	R-4.55±3.37	p<0.01	197	R-4.95±3.78	p<0.01
11.	Present study [Garhwal]	201	R-8.71±2.54 L-8.06±2.77		199	R-12.31±2.53 L-11.76±2.73	

n: Number,SD: Standard deviation,R: Right, L: Left



Graph 1: Comparison of Carrying angle of both males and females found in this study with those reported by other authors in different ethnic groups of India



Graph 2: Comparison of Carrying angle of both males and females found in this study with those reported by other authors in different ethnic groups of world

Significant differences [p<0.01] are found between the values of Carrying angle found in the present study and those reported by other authors in their studies done in different ethnic groups. These regional and racial variations might be due to the influence of environmental and genetic factors during growth and development of an individual.

These variations could also be due to different methods employed by different authors to measure the Carrying angle, ranging from simple Goniometer to complex radiological procedures[10] and differences in the choice of bony landmarks for defining the Carrying angle [26].

This is in agreement with what was documented by Dey S et al. [20] and Patil GV et al.[10] that the Carrying angle shows wide regional variations. Udoaka AI et al.[32] and Eliakaim-Ikechukwu C et al.[30] also found racial influence on Carrying angle in their studies.

Allouh MZ et al.[33] in 2016 also studied variations in Carrying angle with respect to race. The study included 457 Jordanian and 345 Malaysian individuals of age group 18-21 years. All participants were right limb dominant. Carrying angle was significantly greater in Malaysian males as compared to Jordanian males, and significantly smaller in Malaysian females as compared to Jordanian females.

However, Lim V et al. [17] in their study did not find any significant racial variation in Carrying angle.

Conclusion

The present study was conducted to determine the range of normal values of Carrying angle of individuals belonging to Garhwal region of Uttarakhand, and to compare these values with those reported by other authors in their studies done in different ethnic groups.

The study included healthy individuals of both sexes of age group 18-40 years. A total of 400 individuals [201 males and 199 females] were measured. The mean right Carrying angle was found to be 8.71°±2.54° in males and 12.31°±2.53° in females. The mean left Carrying angle was found to be 8.06°±2.77° in males and 11.76°±2.73° in females.

Comparison between the results of the present study with other studies done in different ethnic groups showed wide regional and racial variations in the values of Carrying angle.

This study has established data on the Carrying angle of Garhwal population of Uttarakhand, which could be useful for Orthopaediciansin their clinical practice during management of various elbow disorders, like- fractures, dislocations and in elbow reconstructions and for Biomechanical engineers for preparing elbow replacement implants. The results of this study will also help Forensic experts and Anthropologists during prediction of sex and race of an individual especially in fragmentary skeletal remains. The simple method to measure the

Carrying angle used in this study can also be used in routine clinical practice and in future researches.

Conflict of Interest

None.

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Distinguishing Features of Glyphosate on the Behaviour, Body, Testis and Epididymis of Wistar Rats

Sunday Ogunsuyi Popoola[1], Christopher Lucky Sakpa[2]

Abstract

There is a concerned growing need to increase agricultural products to meet up with growing world consumption using chemicals. Glyphosate (an herbicide) falls into the group of chemicals with perceived infertility. This study investigated the distinguishing features of glyphosate on the behaviour, body, testis and epididymis of Wistar rats. Fifteen adult male Wistar rats were randomly assigned into three groups. Rats in group A (control) received water; group B (low dose) and group C (high dose) received 400mg and 2000mg of glyphosate/kg body weight/day respectively. Experimental period lasted 60days before sacrificing. Excised testes and epididymis were fixed in Bouin's fluid; and subjected to histological and morphometric analyses. Statistical Package for Social Scientists (version 21) was employed for analysis of collated data. The level of statistical significance was set at $p < 0.05$. Varying degrees of physical changes in groups B and C rats were observed. Those in group C further suffered weight loss, shedding of furs, agitation and loose stools. Glyphosate showed decreasing number of spermatozoa within the reproductive system of groups B and C rats. Dose-dependent toxic effects of glyphosate on the testes and epididymides with subfertility was established probably as illustrated on the histology. Glyphosate appeared to have penetrated blood brain barrier with resultant behavioural changes among treated rats. Anti-fertility effect of glyphosate was linked to great reduction of spermatozoa density and disruption of histological characteristics of male reproductive tract. Nevertheless, the use of glyphosate should be genuinely guided or discouraged as applied in some developed countries.

Keywords: Glyphosate; Toxicity; Histology; Male Infertility.

Introduction

In today's world, there is a concerned growing need to increase agricultural products to meet up with growing world consumption. These agricultural products are daily utilized in food, textile, cosmetic, pharmaceutical and wooden industries. For these usages, numerous compounds (fertilizers, pesticides and herbicides) are being added to boost and improve agricultural output [1].

These various uses have posed a dilemma for physicians dedicated to preserving life and improving reproductive health and for food producers employing all forms of techniques to control weeds and pests. Glyphosate falls into the group of chemicals or medications affecting spermatogenesis such as cancer chemotherapy, anabolic steroids, *Cimetidine* and *Spironolactone*; those that decrease follicle stimulating hormone (FSH) levels such as *Phenytoin*; and those that decrease sperm motility such as *Sulfasalazine* and *Nitrofurantoin* [2]. Glyphosate was believed to be relatively non-toxic to mammals [3]. Preposterous verdict of acceptable risks for glyphosate was championed by the government of Germany. Germany played the European Union Rapporteur Member State and submitted their glyphosate renewal assessment report to the European Food Safety Authority (EFSA), recommending formal approval of glyphosate for use in Europe with increase in the acceptable daily intake [4]. Notwithstanding, the recommendation from Germany was alleged to be scandalous following overwhelming evidence of environmental pollution leading to banning of glyphosate in some countries. These countries include: Brazil, Denmark, El Salvador, France, Netherlands and Sri Lanka [5].

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Male infertility has varying causative factors; among these are hormonal imbalance, exposure to spermicidal agents, physical distress and psychological/behavioural problems. It is a fact: the abuse of anabolic steroids is common in sports and entertainment industries among participants to enhance performance. The hormonal imbalance has impact on the pituitary-gonadal axis and its feedback mechanisms. Endocrinologically, the gonadal and sexual functions are mediated by the hypothalamic-pituitary-gonadal axis, a closed-loop system with feedback control from the testicles [6]. In the absence of any biochemical or hormonal derangement, testicular biopsy is indicated to investigate azoospermic males with a normal-sized testis to assess tubular obstruction; and for further investigation of idiopathic infertility [7].

Glyphosate ($C_3H_8NO_5P$, *N-Phosphonomethylglycine*) is a non-specific world's most widely used herbicide in agriculture. As herbicide, it is, most times, sprayed on plants with relatively high levels permeating as residues in food products, water and animal feeds apart from human exposure [8]. Contamination frequently occurs when rain falls directly after application of glyphosate and through flood to the rivers and lagoons [9]. *Detailed mechanism of action of glyphosate in animal cells had been identified* [5].

Glyphosate increases cytosolic calcium (Ca^{2+}) concentration by opening Ca^{2+} channels, thereby permitting Ca^{2+} into the cells with resultant Ca^{2+} overload and cell death [10,11]. In an experiment, glyphosate toxicity was due to Ca^{2+} overload with resultant cell signalling fault and a stress response in defence against depleted antioxidant, thereby, contributing to the death of Sertoli cells hence infertility [12]. Oxidative stress causes the influx of Ca^{2+} into the cytosol and the organelles, most especially, mitochondria and to nuclei thereby quickens the disruption of normal oxidative metabolism through programmed apoptotic or inflammatory necrotic cell death [13,14].

Within the nucleus, Ca^{2+} modulates gene transcription and nucleases that regulate apoptosis (genetically programmed cell death) that involves fragmentation of deoxyribonucleic acid (DNA) [15].

This study seeks to contribute to the fight against the increasing prevalence of male infertility following the consumption of agricultural products that have absorbed glyphosate and other related chemicals from anatomic point of view using adult male Wistar rats (*Rattus norvegicus*). Specific objectives: assessment of behavioural and weight changes; and determination of the effects of glyphosate on the histology of testis and epididymis of Wistar rats.

Limitation of Study

Only light microscope was available for the histomorphological analysis.

Materials and Methods

This study was approved and carried out according to the international standard adopted by the Department of Anatomy, University of Benin, Benin-City, Nigeria. The adult male Wistar rats used for this study weighed 200g and above. A pilot study earlier conducted for a period of two week on 6 adult male Wistar rats divided into three groups of 2 rats in each: A 'Control' gavaged with only distilled water; B 'Low dose' gavaged with 400mg of glyphosate/kg/day; C 'High dose' gavaged with 2000mg of glyphosate/kg/day.

The LD_{50} of glyphosate is above 4000mg/kg body weight/day and the safest tolerant dose to be administered was taken as half: 2000 mg/kg/day [16-18]. The 6 rats were gavaged for 2 weeks. One of the rats in high dose group died, perhaps, due to the metabolic effect of glyphosate on its systems. The main study comprised fifteen rats which were divided at random as well into 3 groups A, B and C of 5 rats in each group. Their weights were recorded at the beginning of the experiment, at weekly interval, and at the point of sacrifice. All the rats were gavaged for 60 days based on their spermatogenic cycle [19]. The rats were sacrificed at day 61.

Each rat for sacrificing was anaesthetized with Chloroform (*Tetrachloromethane*; CCL_4) in cotton wool in an enclosure for 2-3minutes. Thereafter, the rat was laid supine on a dissecting wooden table and pinned. Using a lower abdominal midline approach, the ductus deferens was quickly ligated at the proximal and distal ends to contain semen for sperm analysis. The pelvic cavity was explored to harvest the testes and epididymides and the tissues were preserved in Bouin's solution after weighing. Testicles and epididymides were processed for light microscopy. Morphometric study of testis and epididymis was done simply by measuring the tubular and luminal diameters with metre rule and evaluated the ratio. The data were collated and entered into Statistical Package for Social Scientists (SPSS version 21) software for t-test, and test of significance ($p < 0.05$). Standard error of the mean (SEM) was applied to assess the effect of random changes of the body weight: the higher the value the higher the degree of random changes [23]. Results were represented in words, tables and figures using Microsoft office software.

Results

The results showed varying degrees of physical and behavioural changes in groups B and C rats when compared to control rats. The male rats in group B had increased appetite and weight gain. Conversely, treated rats in group C had loss of appetite, loose stools, shedding of furs, weight loss and agitation. Mean of different parameters were statistically-significant as shown in the table. Mean body weight of rats was decreasing from control group A to high dose group C. The degree of random changes of body weight was highest among rats in group A with the highest SEM value and least in group B. The body weight was increasing among the rats in groups A and B by 1.8g and 1.0g respectively. Contrarily the value was decreasing by 1.1g in group C rats. Average testicular weights were statistically-significantly decreasing with increasing dose of glyphosate.

The slides for control group A rats showed normal histological features of the testes (Figures 1 and 2) and epididymides (Figures 7 and 8). Nevertheless, among the treated groups, there was evidence of reduced spermatozoa population in the testes and epididymides as evidenced by the reduced number of tufty tails of spermatozoa in the lumina of the seminiferous tubules of the testes and the increased spaces between the epithelial linings of the epididymides and the contained spermatozoa in the lumina (Figures 3, 4, 5, 6, 9, 10, 11, 12). There were reducing average luminal-tubular ratio in the treated groups.

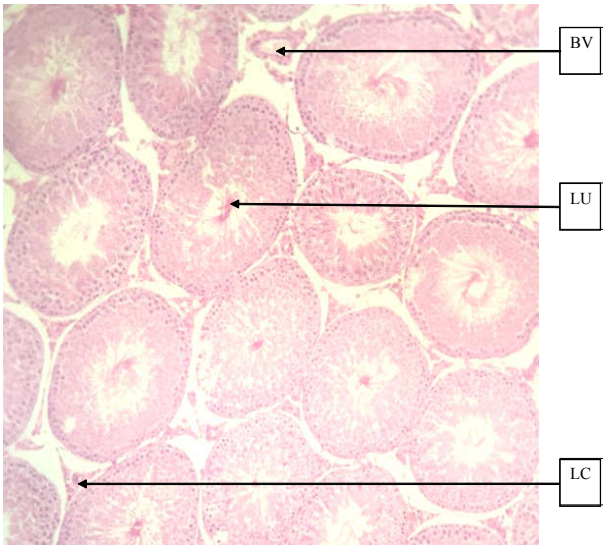

Fig. 1: Photomicrograph of cross section of testes of Group A (Control) male Wistar rats (x100; H & E) showing normal lumen of the seminiferous tubule (LU) densely packed with tufty tails of spermatozoa , blood vessel (BV), interstitial space containing interstitial cells of Leydig (LC). The average luminal-tubular ratio is 1:3.

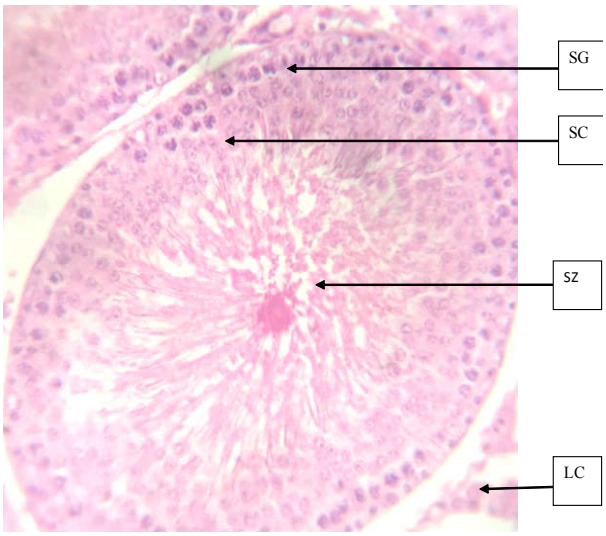

Fig. 2: Photomicrograph of cross section of testes of Group A (Control) male Wistar rat (x400; H & E) showing normal cells of the spermatogenic series; spermatogonia (SG), spermatocytes (SC), lumen of the seminiferous tubules containing densely packed tufty tails of spermatozoa(SZ) and interstitial space containing interstitial cells of Leydig (LC). The luminal-tubular ratio is 1:2.6.

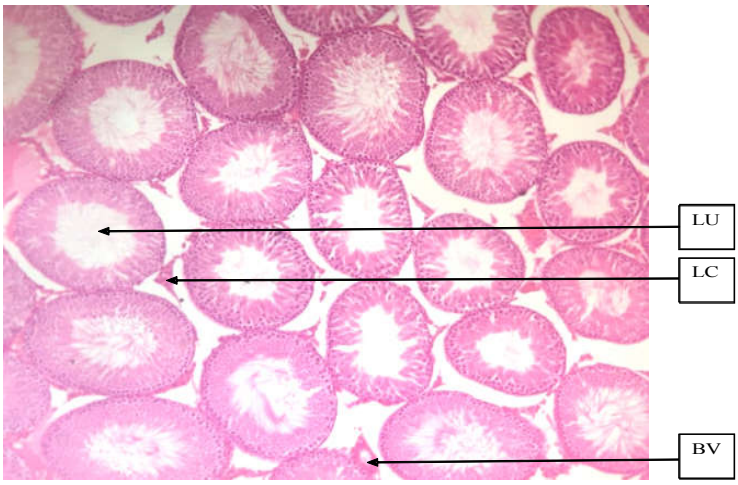

Fig. 3: Photomicrograph of cross section of testes of Group B (400mg/kg body weight/ day of glyphosate) male Wistar rat (x100; H & E) showing cells of the spermatogenic series in sequential arrangement and characterized by scanty number of tails of spermatozoa in most of the lumina (LU) of seminiferous tubules, normal looking blood vessel (BV), interstitial space containing interstitial cells of Leydig (LC). The average luminal-tubular ratio is 1:2.

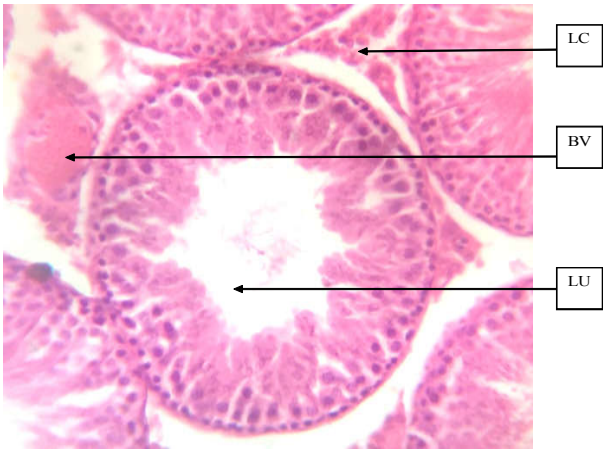

Fig. 4: Photomicrograph of cross section of testes of Group B (400mg/kg body weight/day of glyphosate) male Wistar rat (x400; H & E) showing cells of the spermatogenic series in sequential arrangement and characterized by scanty number of tails of spermatozoa in the lumen (LU) of seminiferous tubule, normal looking blood vessel (BV), interstitial space containing interstitial cells of Leydig (LC). The series appeared separated apart when compared with control group. The luminal-tubular ratio is 1:2.

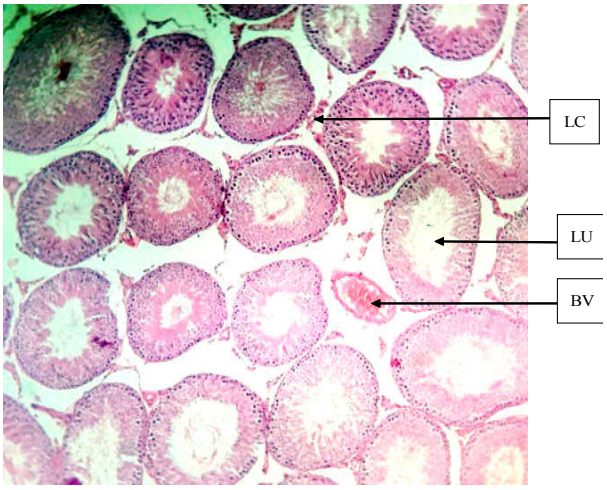

Fig. 5: Photomicrograph of cross section of testes of Group C (2000mg/kg body weight/day of glyphosate) male Wistar rat (x100; H & E) showing cells of the spermatogenic series in sequential arrangement and characterized by scanty number of tails of spermatozoa in most of the lumina (LU) of seminiferous tubules, normal looking blood vessel (BV), widening of interstitial space with dispersed interstitial cells of Leydig (LC) compared to that of control. The average luminal-tubular ratio is 1:2.

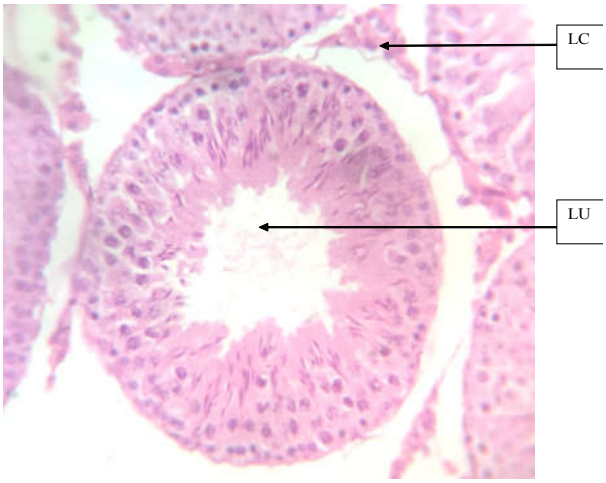

Fig. 6: Photomicrograph of cross section of testes of Group C (2000mg/kg body weight/day of glyphosate) male Wistar rat (x400; H & E) showing cells of the spermatogenic series in sequential arrangement and characterized by scanty number of tails of spermatozoa in the lumen (LU) of seminiferous tubule, interstitial space containing interstitial cells of Leydig (LC). The series are widely separated compared to that of control. The luminal-tubular ratio is 1:2.

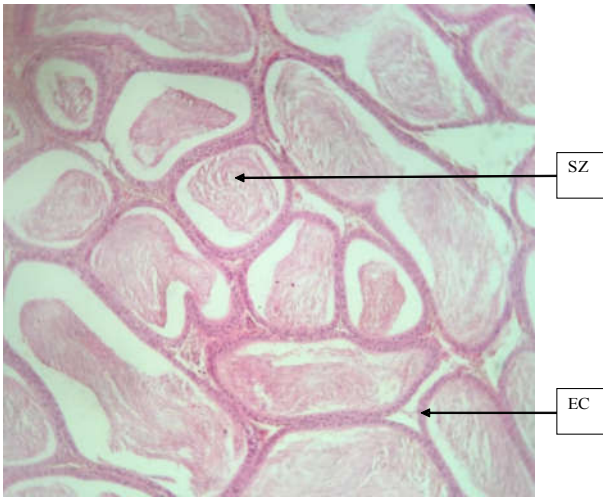

Fig. 7: Photomicrograph of cross section of caudal epididymis of Group A (Control) male Wistar rat (x100; H & E) showing clumps of spermatozoa (SZ) within the lumina and normal looking epithelial cells (EC). The average luminal-tubular ratio is 1:1.2.

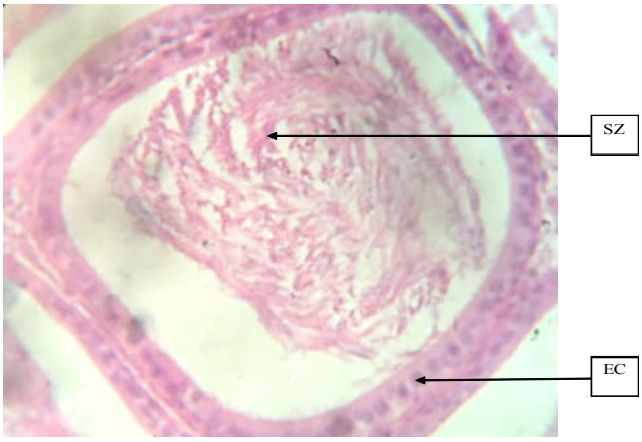

Fig. 8: Photomicrograph of cross section of epididymis of Group A (Control) male Wistar rat (x400; H & E) showing clumps of spermatozoa (SZ) within the lumen and normal looking epithelial cells (EC). The luminal-tubular ratio is 1:1.2.

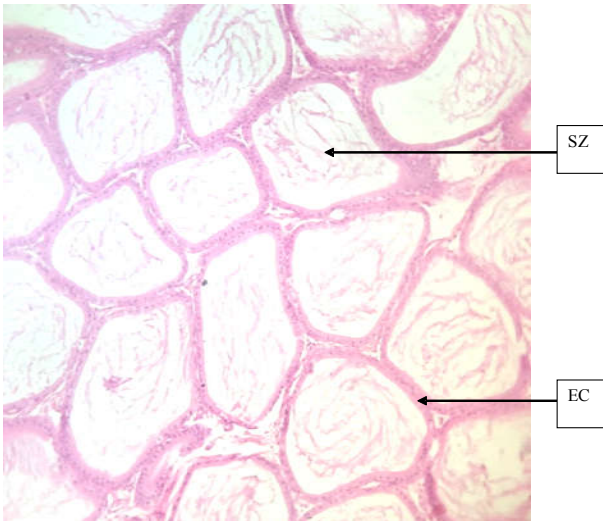

Fig. 9: Photomicrograph of cross section of epididymis of Group B (400mg/kg body weight/day of glyphosate) male Wistar rat (x100; H & E) showing scanty clumps of spermatozoa (SZ) within the lumina and normal looking epithelial cells (EC). The average luminal-tubular ratio is 1:1.1.

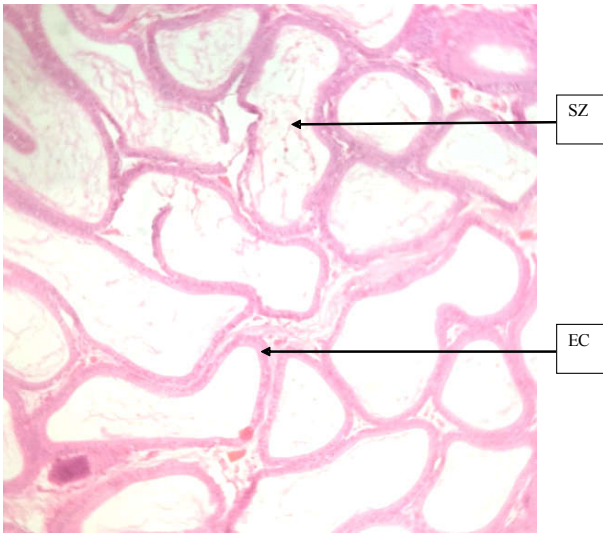

Fig. 11: Photomicrograph of cross section of epididymis of Group C (2000mg/kg body weight/day of glyphosate) male Wistar rat (x100; H & E) showing scanty clumps of spermatozoa (SZ) within the lumina and normal looking epithelial cells (EC). The average luminal-tubular ratio is 1:1.2.

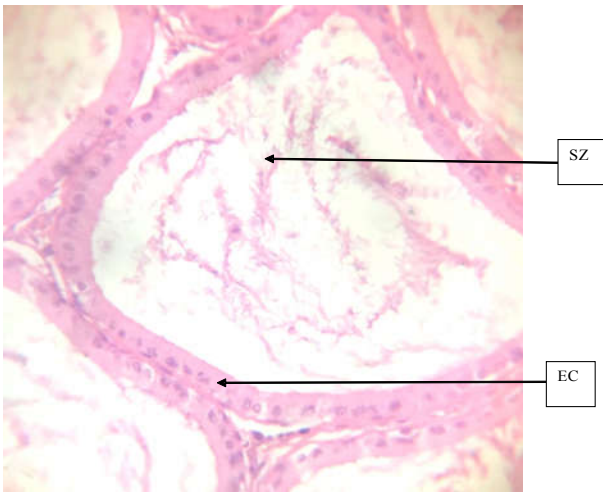

Fig. 10: Photomicrograph of cross section of epididymis of Group B (400mg/kg body weight/day of glyphosate) male Wistar rat (x400; H & E) showing scanty clump of spermatozoa (SZ) within the lumen and disruption of pseudostratified epithelial cells (EC) to cuboidal-like cell when compared with control. The luminal-tubular ratio is 1:1.2.

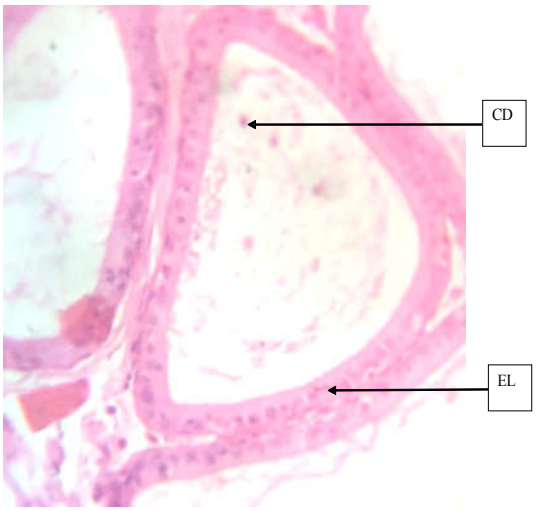

Fig. 12: Photomicrograph of cross section of epididymis of Group C (2000mg/kg body weight/day of glyphosate) male Wistar rat (x400; H & E) showing scanty cellular debris (CD), disruption of brush border and pseudostratified epithelial lining (EL) when compared with control. The average luminal-tubular ratio is 1:1.2.

Table 1: Showing results of Mammary gland staining

Rats	Mawt (g)	mSEM (g)	Mwtc (g)	Matwt (g)
A	236.89	1.872	1.8↑	1.64
B	232.42	1.084	1.0↑	1.35
C	229.76	1.185	1.1↓	1.24
p	0.001	0.031	0.035	0.007

Key
A…….Rat in control group, B…….Rat in low dose group
C…….Rat in high dose group, Mawt…..Mean average body weight (average weight in each group/5)
mSEM…Mean Standard Error of Mean (SEM in each group/5),
Mwtc.....Mean body weight change (awt in each group/5)
Matwt…..Mean testicular weight (atwt in each group/5)
↑…….Increasing in value, ↓…….Decreasing in value, g……..gram (metric unit of weight)

Discussion

The use of Wistar rats for experimental studies has been in vogue over time and results from such studies can usually be extrapolated among *Vertebrata*, including *Homo sapiens loquens*. The gradual affection of physical and behavioural changes among group B and C Wistar rats were demonstration of the toxic effects of glyphosate as previously documented [21].

Glyphosate either appeared to have penetrated the blood brain barrier (BBB) or had a prejudicious bodily physiological consequences accounting for the behavioural changes among treated rats. Excessive perspiration among rats in high-dose group C could further be attributed to the altered physiological function by stimulation of sweat gland apparatus.

The bodily weight gains in groups A and B rats could have been physiological while the decrease in group C rats might have resulted from the increasing intoxicating effect of glyphosate on the treated rats. Besides, dose-dependent decrease in mean testicular weights among group B and C rats showed that glyphosate probably exhibited direct toxic effects on testes. The higher standard error of mean (SEM) of rats in group C demonstrated a statistically-significant higher random effect of glyphosate on the body weight compared to a lesser effect on group B rats. The dose of glyphosate used in treating group B rats could then be said to be appease in terms of body weight assessment. Previous studies conducted on the effect of glyphosate in rabbits showed decline in body weight, libido, ejaculate volume, sperm concentration, semen initial fructose and semen osmolality with accompanying dead spermatozoa [22].

Some of the results with Wistar rats from the present study, for instance, the decreased weight gain among group C rats and decreased testicular weight among treated rats corroborated the previous findings with that of the rabbits.

Among the treated rats, the relative disruption of tubular epithelial linings might have contributed to the fluid accumulation or excessive secretion leading to decrease sperm density within the reproductive tract. Even though, the Leydig cells (LC) appeared normal under light microscope, the state of Sertoli cells (SC) could not be categorically ascertained since electron or other highly-resolute microscopes for the cellular ultra-structure needed to ascertain SC and other structures were not feasible [24].

The presence of celluar debris within the testicles and epididymides of rats in treated high group C futher established the toxic effects of glyphosate in causing infertility with significant exposure as against the German's assertion that the chemical had no reproductive consequences [4]. The deduction from these histological findings showed that glyphosate probably had a direct toxic effect on sperm cells, possibly through apoptotic or necrotic cellular death mechanism [15].

Morphometric analysis of treated rats showed reduction in the average luminal-tubular ratio: increasing luminal diameters while the overall tubular diameters were decreasing. Since breadth or diameter of a tube is directly proportion to the volume and area, thereby, the estimated diameters in this index study could be likened to the volume or content within the lumen. The increasing lumina of treated groups with reduction in clumps of spermatozoa signified another matter, most especially, fluid taking the place of spermatozoa with consequent sub-fertility. The dose related decreasing density of clumps of spermatozoa then showed that the higher the dose of glyphosate the lesser the spermatozoa in the reproductive tract. The relative cytoskleletal architectural disruption of the tubular epithelial layers among rats in treated groups suggested that glyphosate either had direct effect on blood-testis-barrier (BTB) or direct toxic effect on the spermatogenic series and the luminal volumetrics.

Conclusion/Recommendation

The findings from this research work suggested that glyphosate might have penetrated blood-brain barrier (BBB) of the rats leading to thier behavioural intoxication. Glyphosate had deleterious effect on body and testicular weights apart from the spermicidal histological derangement of morphometry of testis and epididymis with consequential reduction of spermatozoa density within the reproductive tract. Put together, glyphosate might have crossed the blood-testis-barrier (BTB) to affect epithelial linings of the male reproductive tracts in treated rats, thereby, corroborating the anti-fertility effect of glyphosate.

The various issues surrounding the banning of glyphosate in some countries should be finalized by intensifying research on the effects of glyphosate on other organ-systems in order to formulate a policy in this part of the world on whether glyphosate should be banned or discouraged. Besides, further studies on the histology using electron microscopic studies of the testis and epididymis should be carried out.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were revealed.

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Original Article

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Morphometric Study of Foramen Magnum

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Abstract

The foramen magnum is a large opening in the occipital bone of the cranium. Diameters of foramen magnum are important because vital structures passing through it and for sex determination of skulls. The dimensions of the foramen magnum are clinically important because vital structures passing through it may endure compression such as in cases of foramen magnum herniation, foramen magnum meningiomas and foramen magnum achondroplasia. The knowledge of foramen magnum diameters is needed to determine some malformations such as Arnold Chiari syndrome, which shows expansion of transverse diameter.

Keywords: Foramen Magnum; Morphometric; Osteology.

Introduction

The foramen magnum is an aperture located at the base of the skull. It is formed by the four portions of the occipital bone (two lateral condyle, one squamous, and one basal)[2] and can present different shapes. The morphometric study of the human skull is a common practice among Anatomists, Anthropologists, and Forensic Experts, as it is a structure of great interest.

It is pathway to structures that crosses the head and neck like the cerebellum, medulla oblongata, meninges, vertebral arteries, and the spinal branch of the accessory nerve (XI Cranial Nerve). Measures of the foramen magnum are relevant in cases of achondroplasia (as there is a high risk of spinal cord stenosis in the base of the skull), Arnold-Chiari malformation (downward herniation of the cerebellar tonsils), foramen magnum meningioma, plagiocephaly, basilar invagination, and others cranial deformities [1,3,4,5,6].

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Aims & Objectives

To study longitudinal diameter, transverse diameter and various shapes of foramen magnum

Material & Methods

Thirty human dry skulls were used for the study from Dept. of Anatomy, SSSMCRI. The measurements were taken by using a sliding digital caliper.

1. The criterion for the Antero-Posterior Diameter (APD) of the foramen magnum was the distance between the basion and opisthion;
2. The Transverse Diameter (TD) criterion was the distance between the points of maximum curvature of the foramen magnum lateral margins
3. Various shapes of foramen magnum observed.

Observations

In present study total of 30 Human Skull used, show that (Table 1) mean Anterio-posterior diameter of foramen magnum is 32.24mm, the observed range for AP diameter were 28.41 to 38.79mm. The mean Transverse diameter 26.73 mm with range was from 23.62 mm to 31.37 mm. The shape of Foramen magum was noted it was observed (Table 2)that the most commonest was Circular shape 14(46.6%), followed by Oval 07(23.3%), Rhomboid 07(23.3%), and least Triangular shape 02(6.7%). The observed shapes of foramen magnum are shown in the Figure 1.

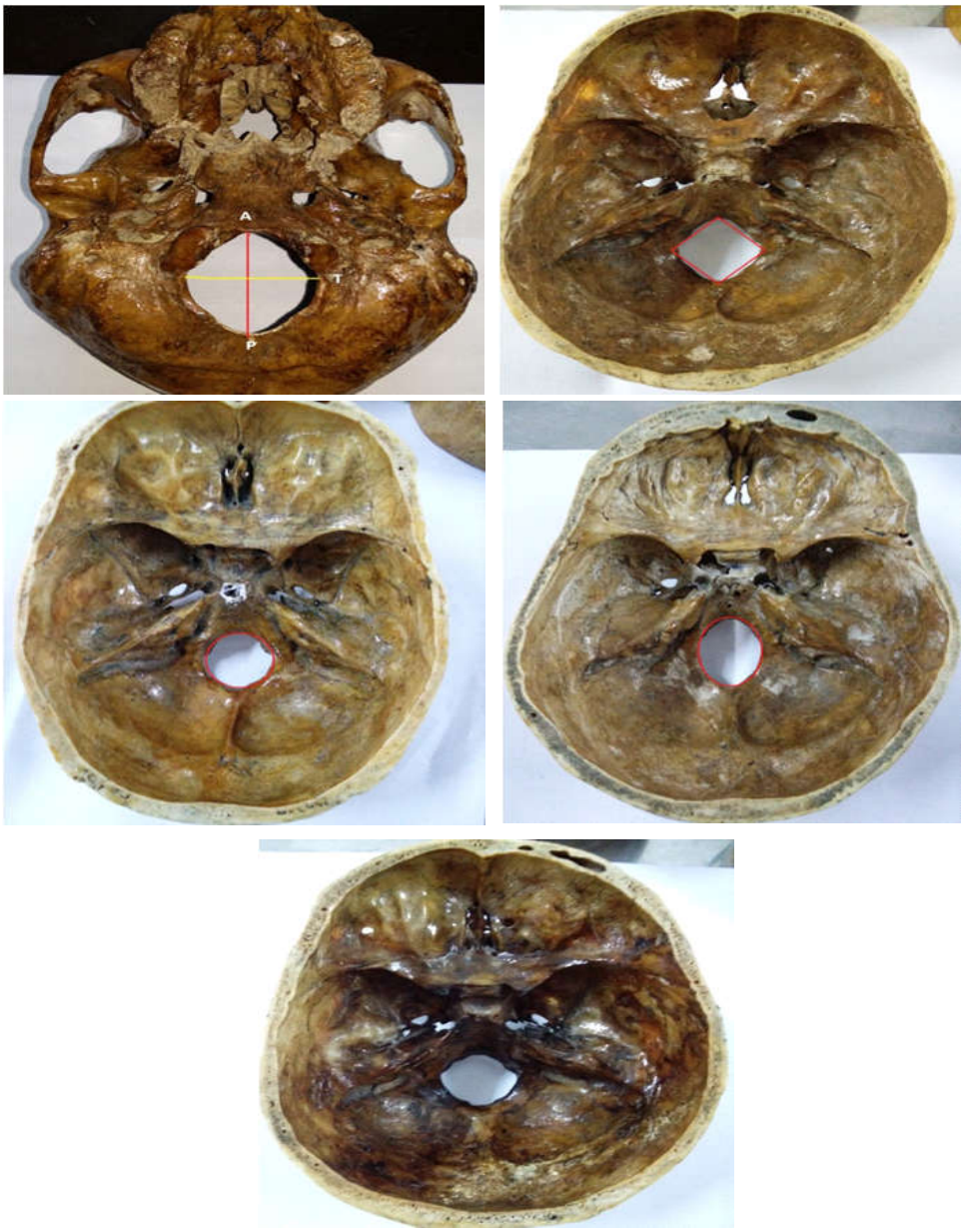

Fig. 1: Different type of Foramen Magnum

Table 1: Anthropometric dimensions of foramen magnum

Parameter	Antero-posterior diameter(mm)	Transverse diameter(mm)
Maximum.	38.78	31.37
Minimum	28.41	23.62
Mean	32.24	26.73

Table 2: Types of foramen magnum observed

Shapes	Numbers	Percentage (%)
Circular	14	(46.6)
Oval	07	(23.3)
Rhomboid	07	(23.3)
Triangular	02	(06.7)

Discussion

Foramen magnum is a transition zone between spine and skull and forms a fundamental component in the complex interaction of bony, ligamentous and muscular structures composing the cranio-vertebral junction. In present study the average antero-posterior diameter of the foramen magnum is 32.24 mm (Range 28.41 to 38.79mm) and Transverse diameter is 26.73 mm (Range 23.0 to 31.37 mm). Muthukumar & Swaminathan [7] observed that the average antero-posterior length of the foramen magnum was 33.3 mm (Range 27–39 mm) and the transverse diameter was 27.9mm (range 23–32 mm). In the present study, the anteroposterior diameter of foramen magnum was more than the transverse diameter. It has also been reported that longer anteroposterior dimension of foramen magnum permitted greater contralateral surgical exposure for condylar resection in transcondylar approach.

Study of the shape and size of the foramen magnum is crucial to determine pathological changes caused by diseases such as: achondroplasia, occipital vertebra, basilar invagination, condylar hypoplasia, and atlas assimilation, Jeune's asphyxiating, thoracic dystrophy, Marchesani's syndrome, foramen magnum meningioma, Arnold-Chiari malformation, and plagiocephaly. Those diseases can cause compression of the structures that traverses the foramen magnum and produce symptoms like respiratory complications, lower cranial nerve dysfunctions, upper and lower extremity paresis, hypo or hypertonia, hyperreflexia or clonus, and general delay during motor development can appear [8,9]. Testut and Latarjet [10] stated that the difficulty of bony resection during surgery is directly proportionate to the size of the foramen magnum.

Conclusion

The morphometric analysis of foramen magnum and its variations is important not only for anatomists but also to the anaesthetist, neurosurgeons, orthopadicians, radiologists. The shapes can guide surgeons in instrumentation and manipulation around this region.

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Original Article

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Variations in the Morphology of Gallbladder: A Cadaveric Study with Emphasis on Surgical Implications

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Abstract

Introduction: Gall bladder is flask shaped and usually lies attached to the inferior surface of the right lobe of the liver by connective tissue. It lies in a shallow fossa in the liver parenchyma covered by peritoneum continued from the liver surface. Cholecystectomy is the single most common intra abdominal operative procedure and it is estimated that about 450,000 cholecystectomies were performed annually. Murphy's sign is elicitation of tenderness where the right lateral plane touches the 9th costal cartilage and the fundus of the gall bladder usually felt at this level. Hence the present study aims to find out the variations in the position of fundus of gall bladder. *Methods:* 87 liver specimens were made use for the study. The relationship of the fundus of the gall bladder to the inferior margin of the liver, congenital anomalies and peritoneal relations of the gall bladder was studied. *Results:* The relationship of the fundus of the gall bladder to the inferior margin of the liver had been classified into supramarginal, marginal, inframarginal and their percentages are 28.69%, 20.33% & 33.89% respectively. The folded fundus of the gall bladder was seen in 5 of 57 specimens. Congenital absence of gall bladder was observed in two liver specimens forming 1.75% of 57 specimens. Section of the liver was made to see the presence of intrahepatic gall bladder there was no gall bladder. Bits of liver tissue were sent for histopathological study and the tissue showed biliary cirrhosis. *Conclusion:* The occurrence of congenital anomalies and anatomical variations of gall bladder are not common but can be of clinical importance. The growing importance of such variations, lie not only from the point of biliary disease but also with respect to the various invasive techniques in the diagnosis and treatment of gall bladder.

Keywords: Gall Bladder; Cholecystectomy.

Introduction

Gall bladder is flask shaped and usually lies attached to the inferior surface of the right lobe of the liver by connective tissue. It lies in a shallow fossa of the liver parenchyma and is covered by peritoneum continued from the liver surface. Cholecystectomy is the single most common intra abdominal operative procedure and it is estimated that about 450,000 cholecystectomies were performed annually. Developmental anomalies in extrahepatic biliary apparatus have been emphasized by Rabinovitch et al. It is difficult to assess the percentage of anomalous gallbladders that undergo pathologic changes. It is clear from available literature that considerable percentage of such anomalies produce symptoms in adult life. These anomalies are the site of serious pathologic changes that they become important clinically. Gall bladder develops from a small hollow bud which arises from the duodenum and grows upwards into the septum transversum. This bud divides into two, of which one forms the gallbladder and cystic duct and the other gives rise to the main mass of the glandular substance of liver. Gross in 1936 gave comprehensive details of gall bladder.

The parts of the gall bladder are from below upwards : fundus, Body and Neck. The fundus is the lower expanded free end of the gall bladder which projects below the liver and is directed downwards, forwards and to the right meeting the anterior

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abdominal wall at an angle of 30^0. The neck forms an S shaped curve and extends from the body to the cystic duct. From the neck a small diverticulum known as Hartmann's pouch sometimes projects downwards and backwards towards the duodenum and the portion of the neck giving attachment to Hartmann's' pouch is sometimes called the "Isthmus of Gall bladder." Jaba Rajguru in 2012 informed that common pattern of variations exist in extra hepatic biliary apparatus. It is essential to know about the development and normal anatomy of biliary tract to understand the anatomical and embryological anomalies.

The different patterns of variation in the extrahepatic biliary apparatus reported by Boyden, 1926, Gross, 1936, Hollinshead, 1983, Shaher, 2005. The knowledge of these variations will make the laparoscopic procedures easier, though preoperative diagnosis. Murphy's sign is elicitation of tenderness where the right lateral plane touches the 9^{th} costal cartilage and the fundus of the gall bladder usually felt at this level. Hence the present study aims to find out the variations in the position of fundus of gall bladder.

Aim

To know about the anatomical and morphological variations of the gall bladder.

Materials and Methods

In the present study totally 95 gallbladder specimens were used and the study was conducted in Rajah Muthiah Medical college and the specimens obtained from formalin fixed cadavers used for undergraduate students study during the period of 6 years. Cadavers with obvious abdominal surgery and crush injury to the abdominal organs were excluded from the study.

The following parameters were studied

- Maximum length of gallbladder
- Maximum transverse diameter,
- Shape of the gallbladder
- Length of gallbladder below the inferior border of the liver.

Length and transverse diameter was measured using metallic measuring tape gradated in centimeters.

Results

The mean length of the gallbladder was 9 cm in the present study. The smallest gallbladder was 4.2 cm in length and 11.7 cm was the maximum length of the gallbladder. In 61% specimens the length of the gall bladder was in between 7-10 cm in length.

The mean transverse diameter of the gallbladder was 3.16 cm in length. The shortest diameter was 1.7 cm in length. In 53% of specimens the range of the transverse diameter was in between 2-4.5 cm in length.

Various shapes of the gallbladders were observed. (Table 1). The most common observation

Table 1: Comparison of length, breadth and shape with previous studies

S. No	Name of the Author	Length of the gall bladder(cm)	Breadth of the gall bladder(cm)
1	Lee McGregor, Decker and Plessis (1986)	7.5-10	-
2	Turner&Fulcher/(2000)	10	3 – 5
3	Moore and Dalley (2006)	7 - 10	-
4	Chari and Shah (2008)	7-10	2.0-5.0
5	Vakili and Pomfret (2008)	7-10	4.0
6	Standring (2008)	7-10	
7	Rajguru, Khare, Jain et al. (2012)	5-12	2.5-5.0
8	Nadeem, G(2016)	4.5-11.6	2.5-5.0
9	In the present study	4.2 – 11.7	1.7- 4.5

Table 2: Shape of the gallbladder

S. No	Shape of the gall bladder	Percentage
1	Pear	76.25
2	Flask	12.6
3	Cylindrical	4.2
4	Hour Glass	2.1
5	Retort	3.55
6	Irregular	1.4

was pear shaped gall bladder and the second common was flask shape. The relationship of the gallbladder to the inferior margin of the liver had been classified into supra marginal, inframarginal & marginal. In the present study the most common type was inframarginal in 43.12% specimens, supra marginal in 36.55% specimens and marginal in 20.33% specimens.

The folded fundus of gallbladder – its appearance in cholecystogram is referred to as "Phrygian Cap". In the present study 9 specimens showed folded fundus of gallbladder. Congenital absence of gall bladder was observed in one liver forming 1.75 % of 57 specimens. That liver showed multiple accesses. Section of the liver was made to see the presence of intrahepatic gallbladder there was no gallbladder. Bits of liver tissue were sent for histopathological study and it showed biliary cirrhosis.

In the most of the specimens the superior surface of gall bladder was not covered by peritoneum and was situated in the fossa for gall bladder.

Left margin usually plastered to the liver, right margin was free and covered by peritoneum and was separated from the fossa. Whenever it was inframarginal, fundus of the gall bladder was covered by peritoneum. In one liver from neck of the gallbladder peritoneal fold extended from it to the I part of the duodenum.

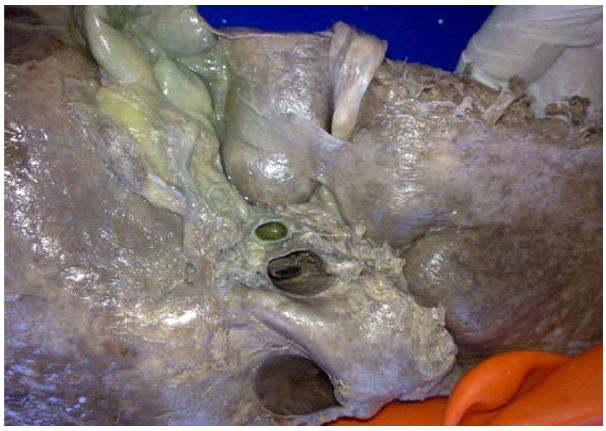

Fig. 1: Folded fundus of gallbladder

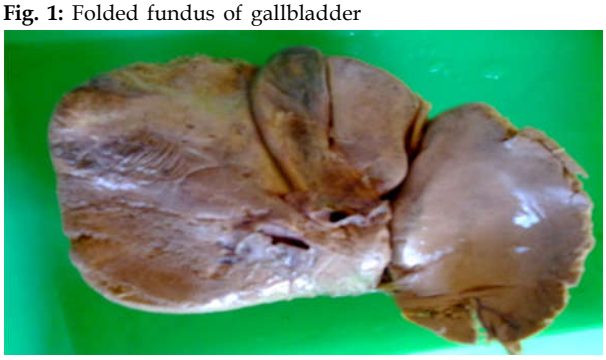

Fig. 2: Infra Marginal gallbladder

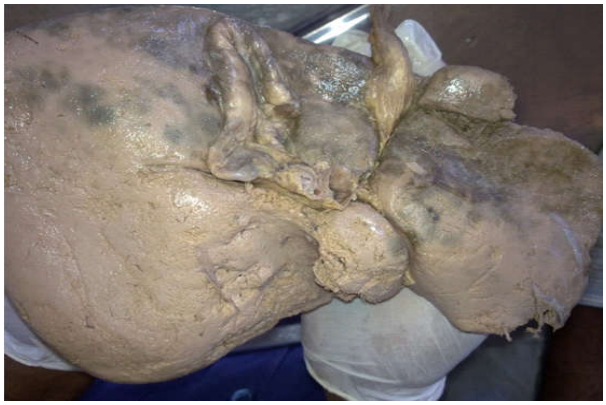

Fig. 3: Marginal gallbladder

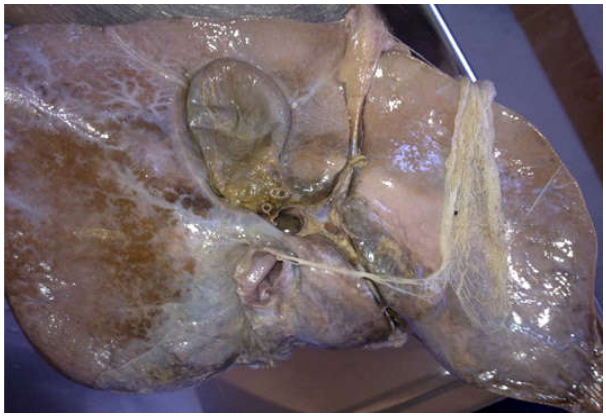

Fig. 4: Supra marginal gallbladder

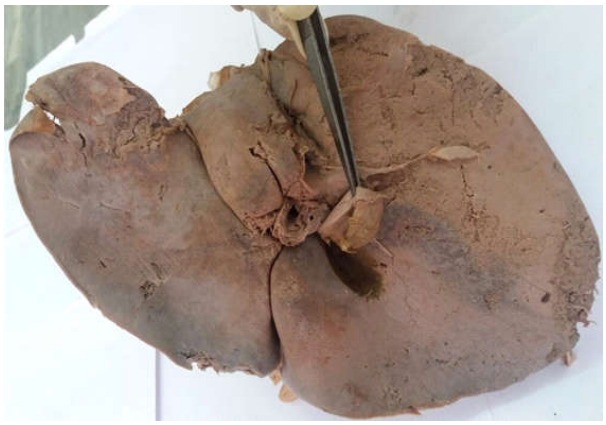

Fig. 5: Presence of double neck in the gallbladder

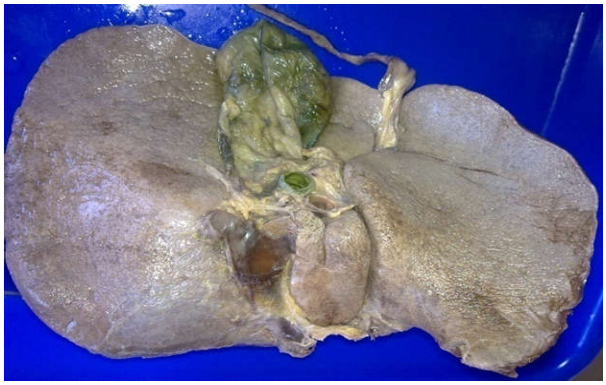

Fig. 6: Presence of Hartman's pouch

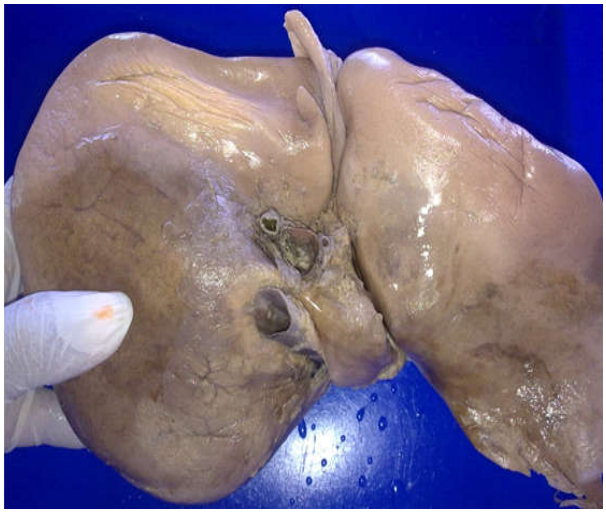

Fig. 7: Absence of gallbladder

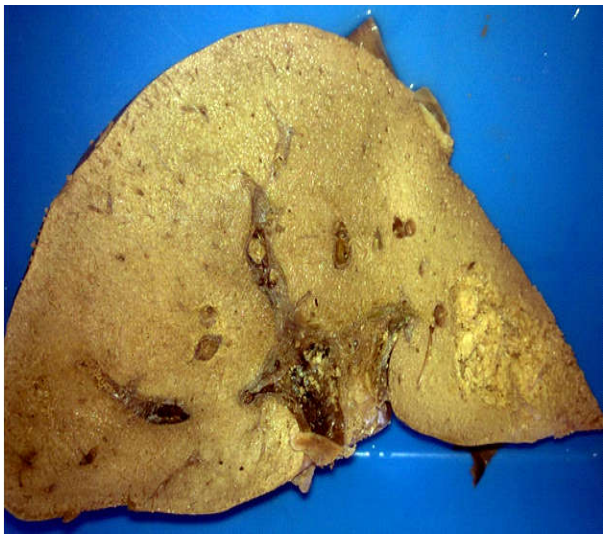

Fig. 8: Inside the liver also there is no gallbladder tissue

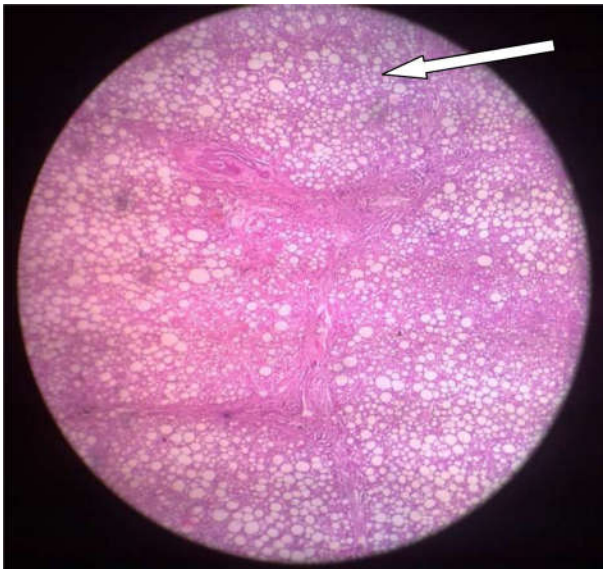

Fig. 9: Histopathological Finding—Biliary Cirrosis Is Seen

Discussion

The relationship of the fundus of the gall bladder to the inferior margin of the liver had been reported by several authors. Lurge (1913) classified the relation of fundus to the edge of the liver into supra marginal, marginal and infra marginal. He reported 33% specimens were supramarginal, 13.9% were marginal and 53% were inframarginal type. In the present study also we observed the most common type was inframarginal in 43.12% specimens and 36.55%, 20.33% were supra marginal and marginal respectively. The measurements of length and breadth were compared with the previous studies in Table. no – 1.The measurement of length and transverse diameter found in present study it similar to that found by Rajendra et al in 2015.

The size of the gallbladder will increase after vagotomy and in diabetes due to autoimmune neuropathy and micro gallbladder with cystic fibrosis was seen in sickle cell disease patients, during pregnancy and extreme obese people. Gore, Fulcher, Taylor et al. (2000).

Pear shaped gallbladder was observed in 76.25% of specimens which was coincides with the findings of Rajguru, Khare, Jain et al. (2012), Moore and Dalley (2006) and Chari and Shah (2008). Rajguru, Khare, Jain et al. observed 5% of specimens were flask shaped and 3.33% specimens were cylindrical shaped. In the present study 12.6% specimens showed flask shape and 4.2% specimens were cylindrical. Irregular shaped gallbladder was sent in 1.67% cases by Rajguru, Khare, Jain et al. (2012) reported 1.67% specimens were irregular shaped and in the present study it was 3.15%. Folded fundus of gall bladder was first described by Bartel (1916) who reported 43 cases at autopsy. Boyden (1935) found the same anomaly in 7.5% of the 80 autopsy specimens and in 3.6% of the cholecystograms while Lichtenstein (1937) reported 3% in 212 specimens. Sreekanth et al and J Desai reported 2% and 8% specimens showed folded fundus of the gallbladder, in the present study in 8.47% of specimens observed with folded fundus. Hartmann's pouch was first described by Broca (1938) has been regarded as contrast feature of normal gall bladder (Hollenshead 1971, Gray 1984) but Davis et al considered it to be pathological. Ejick, Veen, Lange et al. (2007) has reported that Hartmann's pouch is a morphological entity and not an anatomical entity Futura et al. reported that there was a higher incidence Hartmann's pouch in females. Nadeem G reported 10% specimens showed hartmann pouch and in the present study it was 6.77% specimens.

The incidence of congenital absence of the gall bladder is certainly low, but it is not known exactly. Latimer, Mendesy and Hage quoted various estimates of 0.065%, 0.3% and 0.075%. Finney and Owen stated that congenital absence of the gall bladder has been said to be about twice as common in women's as in men. In the present study one male cadaver gall bladder was congenitally absent. Mahato NK had been reported septation of the gall bladder may be single or multiple and it will be associated with cholelithiasis and abdominal colic. In the present study we didn't observe any septations in the gall bladder. A double cystic duct is extremely rare. Of the 9 case reports in the English and European literature, it is associated with a double gallbladder over 80% of the time. Shivhare R reported they were three types of variations in the cystic ducts. In the present study we observed the presence of double neck in one specimen.

Conclusion

In the present study we observed the variations in the shape and position of the gall bladder. Anatomical variations of Gallbladder shape and position were taken into the account for Radiological study, Investigative procedures, Surgical interventions, Clinical Implications, Embryological explanations and Comparative anatomy surgeons must be aware of the many possible anatomic anomalies to minimize the risk of complications. These variations generally remain symptoms free but often lead to complications. Finding out of these anatomical variations and make difficult operations easy, to prevent post-operative complications and thus reducing morbidity and mortality. There is tremendous increase in number of laparoscopic Cholecystectomies. So, thorough knowledge in morphology, anatomical variations and congenital anomalies of gallbladder is important.

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Original Article

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Morphological Study of Coronoid Process of Mandible and its Clinical Significance

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Abstract

Introduction: Coronoid process is a beak like projection flattened from side to side at the antero-superior aspect of the ramus. This process gives attachment to two important muscles of mastication –Temporalis muscle attached to apex, whole of the medial surface and anterior part of lateral surface of the coronoid process. *Material and Method:* coronoid process of 110 mandibles was observed on both sides for its shape. The length of the coronoid process was taken from the line tangential to the deepest part of mandibular notch to the apex. *Result:* Rounded type of coronoid process was found in 94 (42.73%), triangular in 74 (33.63%) and hook shape in 52 (23.64%). 74.55% mandibles were showing bilateral symmetry and only 25.45% of mandibles were showing difference in the shapes in both sides. Rounded type more prevalent in females (45%) than males (41.43%), whereas hook shape more prevalent in females (25%) than males (22.86%) and triangular more prevalent in males (35.71%) than females (30%). Mean and SD for length of coronoid process was calculated. *Conclusion:* The knowledge of variation in the shape of coronoid process is important for maxillofacial surgeons for the reconstructive surgeries.

Keywords: Coronoid Process; Mandible; Morphology.

Introduction

In human there are two coronoid process, one present in ulna and another present in mandible. Coronoid process is a beak like projection flattened from side to side at the antero-superior aspect of the ramus. In Greek, "korone" means "like a crown". This process gives attachment to two important muscles of mastication –Temporalis muscle attached to apex, whole of the medial surface and anterior part of lateral surface of the coronoid process. Rest of the lateral surface gives attachment to anterior fibres of masseter. The shape and size of coronoid process is influenced by dietary habit, genetic constitution, hormone and mainly by temporalis muscle activity. The knowledge of variation in the shape of coronoid process is important for maxillofacial surgeons for the reconstructive surgeries. It can be easily harvested as donor graft site for reconstruction of orbital floor deformities act as an anthropological marker for detection of races in forensic studies and anthropological studies. Hence the present study was undertaken to shapes of coronoid process and their prevalence in dry adult human mandibles of both male and female of north Gujarat population.

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Materials and Methods

The present study was undertaken on 110 dry adult human mandibles (220 sides) available in Anatomy departments of various Medical Colleges of North Gujarat population. Any mandible broken, asymmetrical or deformed was excluded from the study. Out of 110 mandibles 70 were of males and 40 females. In this study, coronoid process of 110 mandibles was observed on both sides for its shape. The shape of coronoid process was classified into 3 types:

1. Triangular- tip pointing directly upwards
2. Rounded- tip rounded
3. Hook- tip pointing backwards.

The length of the coronoid process was taken from the line tangential to the deepest part of mandibular notch to the apex. It was measured by using vernier caliper.

Results

In present study, we observed rounded type of coronoid process (42.73%) more prevalent than triangular shape (33.63%) and hook shape (23.64%). 74.55% mandibles were showing bilateral symmetry and only 25.45% of mandibles were showing difference in the shapes in both sides (Table 1, Figure 1).

Rounded type more prevalent in females (45%) than males (41.43%), whereas hook shape more prevalent in females (25%) than males (22.86%) and triangular more prevalent in males (35.71%) than females (30%) (Table 2, Figure 2).

The hook shaped coronoid process was present in 52 sides (Figure 3). In 36 mandibles, it was found bilaterally and in 16 mandibles, it was found unilaterally. Of the 6 mandibles which had a hook shaped coronoid process on the right side, the corresponding sides had 4 triangular shaped and 2 rounded coronoid processes. Of the 10 mandibles which had a hook shaped coronoid process on the left side, the corresponding sides had 6 triangular shaped and 4 rounded coronoid processes.

The triangular coronoid process was seen in 74 sides. In 52 mandibles, it was found bilaterally while in 22 mandibles it was found unilaterally (Figure 4). The 14 mandibles, which had a triangular coronoid process on the right side, the corresponding sides had 6 hook shaped and 8 round shaped coronoid process. The 8 mandibles which had a triangular coronoid process on the left side, the corresponding sides had 4 hook shaped and 4 round shaped coronoid process.

The rounded coronoid process was present in 94 sides (Figure 5). In 76 mandibles, it was found bilaterally and in 18 mandibles it was found unilaterally. Of the 8 mandibles which had a rounded coronoid process on the right side, the corresponding sides had 4 triangular shaped and 4 hook shaped coronoid process. Of the 10 mandibles which had a rounded coronoid process on the left side, the corresponding sides had 8 triangular shaped and 2 hook shaped coronoid process.

The length of the coronoid process with three different types observed in 110 dry human mandibles was mention below (Table 3). Gender wise length of different shapes of coronoid process was mention below (Table 4).

Table 1: Incidence of different shapes of coronoid process with their percentage

Shape	Number	Bilateral	Unilateral		Percentage
			Right	Left	
Hook	52	36	6	10	23.64
Triangular	74	52	14	8	33.63
Rounded	94	76	8	10	42.73

Table 2: Gender wise distribution of different shapes of coronoid process with their percentage

Shape	Male(N=140)				Female(N-80)			
	Percentage	Bilateral	Unilateral		Percentage	Bilateral	Unilateral	
			Right	Left			Right	Left
Hook	22.86	12	4	4	25	6	2	6
Traingular	35.71	18	8	6	30	8	6	2
Rounded	41.43	26	2	4	45	12	6	6

Table 3: Length of the coronoid process in 110 dry human mandibles

Shape	Length of coronoid process	
	Right (Mean + SD)	Left (Mean + SD)
Hook	16.12 + 1.82	15.93 + 1.79
Triangular	16.14 + 2.56	17.01 + 2.30
Rounded	16.09 + 1.76	16.24 + 2.38

Table 4: Comparison of various studies on the shapes of coronoid process

Shape	Male		Female	
	Right (Mean+SD)	Left (Mean+SD)	Right (Mean+SD)	Left (Mean+SD)
Hook	17.12 + 1.22	16.96 + 1.20	14.12 + 0.94	14.56 + 1.54
Triangular	17.50 + 1.51	17.95 + 1.84	13.61 + 2.16	14.74 + 1.65
Rounded	17.12 + 1.35	17.33 + 1.64	14.48 + 0.94	14.42 + 2.30

Table 5: Comparison of various studies on the shapes of coronoid process

Author	Type of coronoid process		
	Hook %	Triangular %	Rounded %
Isaac et al.[8]	27.4	49	23.6
Vipul et al.[9]	24.58	54.17	21.25
Pradhan et al.[10]	17.93	46.73	35.3
B. Lalitha et al.[11]	17.12	58.79	28.08
Hossain et al.[12]	45	29.65	25.35
Present study	23.64	33.63	42.73

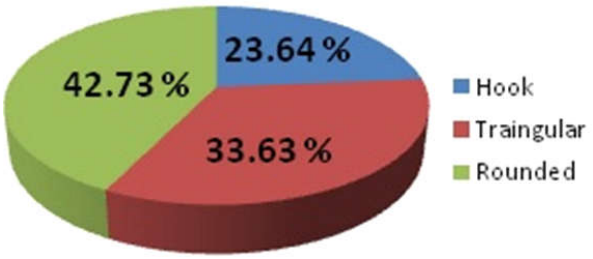

Fig. 1: Pie chart showing the distribution of various shapes of coronoid process in adult human mandible

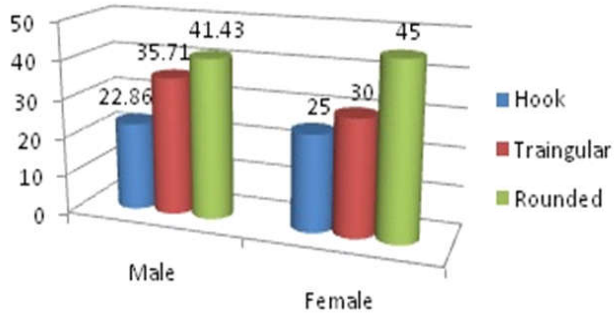

Fig. 2: Bar diagram showing gender wise distribution of various types of coronoid process in adult human mandibles

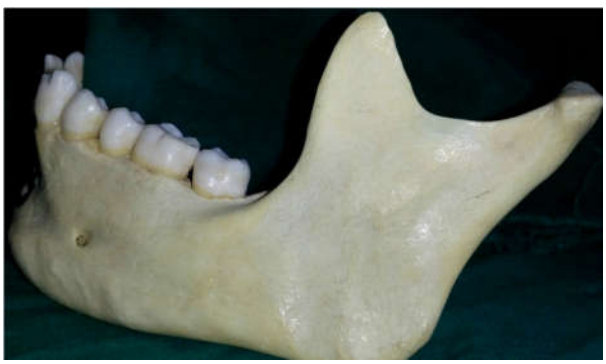

Fig. 4: Triangular coronoid process

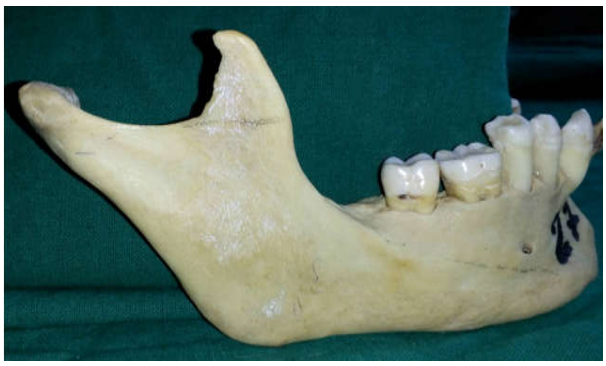

Fig. 3: Hook shape coronoid process

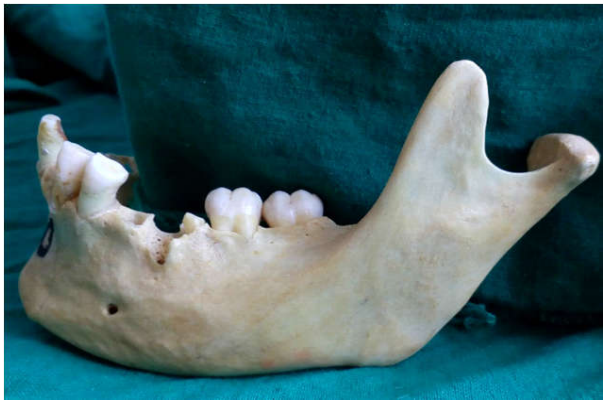

Fig. 5: Rounded coronoid process

Discussion

The coronoid process, coronoid meaning 'crow', has been described as one of the bony processes of the ramus of the mandible [1]. Williams et al described the coronoid process as a flat triangular process [2]. Triangular coronoid processes have been illustrated

by Hamilton [3], Romanes [4], Snell [5], and Basmaijan et al. [6], Schafer et al. [7] described the coronoid process as beak-shaped.

In present study, we observed rounded type of coronoid process (42.73%) more prevalent. In contrast to our study, Issac et al. [8], Vipul et al.[9], Pradhan et al. [10], B.Lalitha et al.[11] observed triangular type were more prevalent in their studies (Table 5). In present study, we observed hook shaped coronoid process (23.64%) least prevalent which is similar with Pradhan et al. [10] and B Lalitha et al. [11]. (Table 5) In the present study the, round and hook shaped types were the most and the least prevalent in males (41.43% and22.86%) and as compared to Isaac et al. [8] and Hossain [12] where triangular and rounded were most and least prevalent in males (46.5% and 23.5%) respectively. The round and hook shaped types were the most and the least prevalent in female (45% and 25%) which is similar with B. Lalitha et al.[11] (39.65% and 25.86%) respectively (Table 6).

Table 5: Comparison of the variations in the shapes of coronoid process in relation to gender with other studies

Author	Type of coronoid process					
	Hook (%)		Triangular %		Rounded %	
	Male	Female	Male	Female	Male	Female
Isaacet al.[8]	30	22.8	46.5	53.5	23.5	23.6
Vipul et al.[9]	21.33	21.11	56	51.11	22.66	27.77
Pradhan et al.[10]	21.87	13.63	45.83	47.72	32.29	38.63
B. Lalitha et al.[11]	11.36	25.86	68.18	34.48	20.45	39.65
Hossain et al.[12]	44.95	45.12	27.27	35.37	27.78	19.51
Present study	22.86	25	35.71	30	41.43	45

In present study, the size of coronoid process was found to be approximately 0.27 mm longer on the left side than on the right side, in contrast to our study, S nayak et al.[13] found the right side coronoid process was 1.5 mm longer than the left side. The size of coronoid process was found to be approximaely 3.15 mm longer in males than females which is similar with S nayak et al.[13]. Triangular coronoid process was found to be the longest followed by round and then hook shaped which is similar with S nayak et al.[13]. Male hormonal impact on muscle growth, bone remodeling and psychology probably lead to enhanced functional stress on mandible due to mastication as compared to that in females [13].

Autogenous bone grafts can be obtained from ilium, rib and calvarias; but each site has its own associated morbidity. A local bone graft from Coronoid process of mandible can be used as it can be harvested easily, minimal morbidity, no cutaneous scarring as bone is harvested intraorally. A Coronoid process graft can be used for alveolar defects repair, orbital floor repair, maxillary augmentation, repair of non-union fracture of mandible. The grafts are widely used in reconstruction of osseous defects in oral and facio-maxillary region [9]. The Coronoid process makes an excellent donor graft site for reconstruction of orbital floor deformities [14]. Clauser et al. [15] reported the use of a temporalis myofascial flap both as a single and as composite flap with cranial bone, as the arteries supplying the coronoid process, arise from vessels that supply the muscles attaching to these processes, and generally not from the inferior alveolar artery which primarily supplies the mandibular body and teeth. Coronoid process skin island can be used in all aspects of reconstructive craniomaxillofacial surgery including trauma, deformities, tumors, temporomandibular joint ankylosis and facial paralysis. No functional limitations were apparent after removing the coronoid process.

Conclusion

Detailed knowledge of variations in the shapes of coronoid process is important for anatomist, anthropologists and forensic researchers. It also important for maxillofacial surgeons as it is used as graft material to reconstruct the osseous defects in maxillofacial regions.

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Original Article

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Morphometric Study of Lateral Menisci of the Adult Knee Joint in North Karnataka Population

Itagi Veeresh K.[1], Mallashetty Nagraj S.[2]

Abstract

Background: The largest articulation in the body is the knee joint. Shallow concave surface of the tibia lodges the condyles of femur in unequal manner. Semilunar cartilages called menisci lie in knee joint attached firmly to the intercondylar area of tibia. The menisci are liable to injury resulting from twisting strains applied to flexed weight bearing knee. The mean annual incidence of meniscal tears is about 60-70 per 100,000 with a male to female ratio ranging from 2.5:1 to 4:1. This study gives morphometric data for preparing meniscal allograft for people of this region so that accurate matching can be done in meniscal transplantation. *Objective:* To analyze peripheral and inner border lengths, thickness, width, distance between anterior and posterior horns of adult lateral menisci of right and left knee joints and to compare with that of meniscal parameters available in the literature. *Material and Methods:* For this study, 60 lateral menisci from 60 adult human knees available in the Department of Anatomy were studied and analyzed. *Results:* Paired t-test with $p<0.05$ significance was applied for values expressed as Mean±SD, all the parameters of left sided lateral menisci were higher but the difference was not statistically significant ($p>0.05$). *Conclusion:* This study is useful for the health professionals who work with treatment of meniscal injuries to create an awareness of the anatomical variations that may exist in the menisci facilitating the rehabilitation process.

Keywords: Menisci; Morphometry; Thickness; Width; Peripheral Length.

Introduction

Semilunar cartilages called menisci lie in knee joint attached firmly to the intercondylar area of tibia. The menisci provide structural integrity to the knee when it undergoes tension and torsion, also known to transmit tibio-femoral load, prevent synovial impingement, acts as shock absorbers, lubricators of joint and also in assisting in smooth gliding of surfaces over one another [1].

Lateral meniscus is circular and covers 70% of the lateral tibial plateau. The anterior horns of medial and lateral menisci are attached to each other by transverse ligament. The posterior horn of the lateral meniscus is attached to the posterior cruciate ligament and medial femoral condyle through meniscofemoral ligaments of Wrisberg and Humphrey [2,3].

Incidence of lateral meniscal tears are low, as it translates 9 to 11 mm on the tibia during knee flexion [4,5,6]. Due to close relationship of lateral meniscal horn insertion sites with tibial attachment of anterior cruciate ligament it is important with regard to meniscal reconstruction using meniscal allograft with attached bone plugs [7]. The mean annual incidence of meniscal tears is about 60-70 per lakh with a male to female ratio ranging from 2.5:1 to 4:1 [8]. This study gives morphometric data for preparing meniscal allograft for people of this region so that accurate matching can be done in meniscal transplantation.

Objectives

To analyze peripheral and inner border lengths, thickness, width, distance between anterior and posterior horns of adult lateral menisci of right and

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left knee joints and to compare with that of meniscal parameters available in the literature.

Material and Methods

To carry out this study, embalmed human adult limbs of the cadavers available in the Anatomy Department were used. For this study, 60 lateral menisci from 60 human knees, 31 left and 29 right which were dissected previously and preserved with 10% formalin solution were used. Present Cross sectional study included all the cadaveric limbs available in the Department of Anatomy during study period. Cadavers whose lower limbs had abnormal knee joints like exostosis, any deformity, fractures, traumatic injury or menisci with degenerative changes were excluded.

Approach to menisci was started with dissection of skin & muscles at knee joint. To open the joint cavity first longitudinal incision was made anteriorly on both sides of joint capsule, transverse cut was put on patellar ligament and collateral ligament. To appreciate the menisci clearly joint capsule and intraarticular ligaments were cut, condyles were separated from soft tissue attachments around the edges exposing the tibial plateau. After the systematic dissection data were entered on a standardized data collection sheet.

The peripheral length of menisci was determined first to measure the thickness of outer circumference of menisci. A cotton nonelastic thread was placed along the periphery of the meniscus and with small pins the tibial insertion ligaments of meniscus were held in place. Peripheral length is measured as the length of thread from the most anterior part of the anterior insertion area to the most posterior part of the posterior insertion area. In the same manner, by keeping the thread at the inner free edge thinner free border length was measured [9] (Figure 1 & 2). Then the thread with peripheral circumference length is divided into 3 equal parts by using scale & color marker pens. The thread is placed again over the meniscus and the meniscus were divided into 3 equal parts anterior 1/3 (ant. 1/3), middle 1/3 (mid. 1/3) and posterior 1/3 (post. 1/3) respectively (Figure 3). Then the width and the thickness of the meniscus were measured at the above mentioned parts at their midpoint. The distance between (b/w) the anterior horn (AH) & posterior horn (PH) was also measured [9]. A Vernier caliper of 0.10 mm accuracy was used for taking measurements.

Statistical Analysis included mean and standard variations of each variable calculated and their difference between right and left knee menisci was compared by using Student's unpaired t-test, where significance value was $p < 0.05$.

Results

Table 1 shows the lateral menisci parameters of right and left side, it was observed that all the parameters like peripheral length, inner border length, width and thickness at anterior 1/3 (ant.), middle 1/3 (mid), and posterior 1/3 (post.), distance between anterior and posterior horns were higher in left sided lateral menisci, but the difference was not statistically significant ($p>0.05$).

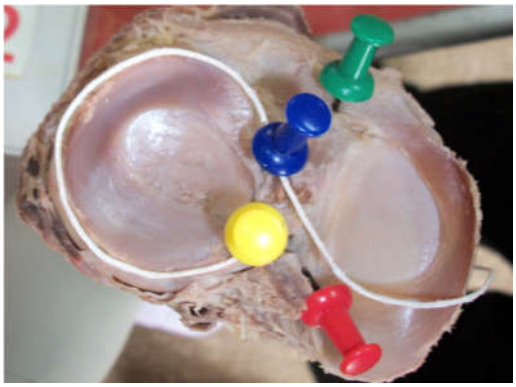

Fig. 1: Showing measurement of peripheral length of lateral meniscus

Table 1: Lateral meniscal parameters in adults (n =60)

Parameters	Right Side (mm)	Left side (mm)	t value	p value
Peripheral Length	87.8 ± 8.39	88.5 ± 7.36	0.371	0.712
Inner Border Length	49.5 ± 8.88	51.8 ± 5.87	1.202	0.234
Width				
Ant 1/3	8.4 ± 2.21	8.8 ± 1.97	0.571	0.570
Mid 1/3	9.2 ± 2.31	9.3 ± 2.61	0.128	0.899
Post 1/3	9.6 ± 1.93	9.5 ± 2.16	0.088	0.930
Thickness				
Ant 1/3	3.8 ± 1.26	3.9 ± 0.87	0.235	0.815
Mid 1/3	4.4 ± 1.58	4.3 ± 1.05	0.425	0.672
Post 1/3	4.7 ± 1.43	4.9 ± 2.25	0.546	0.587
Distance b/w AH & PH	11.4 ± 2.89	12.5 ± 2.62	1.502	0.139

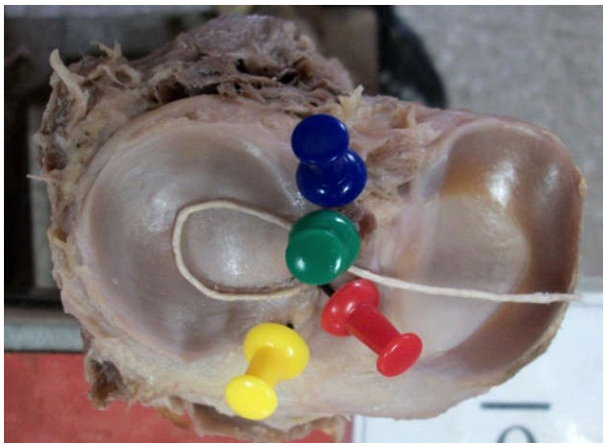

Fig. 2: Showing measurement of inner border length of lateral meniscus

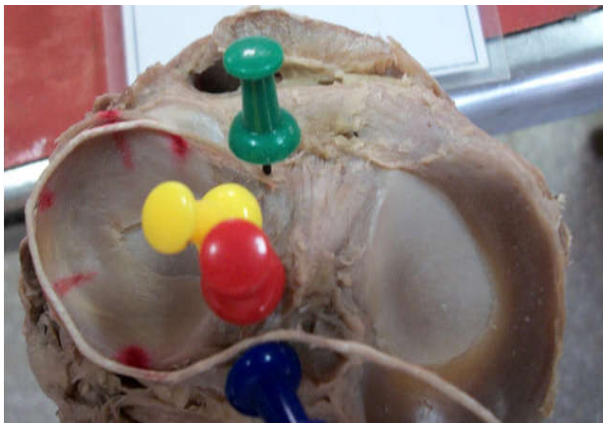

Fig. 3: Showing division of lateral meniscus into anterior 1/3, middle 1/3 & posterior 1/3

Mean values in mm of lateral menisci for peripheral length and inner length were 88.2±7.82 and 50.7± 7.50. Width at ant 1/3 was 8.6±2.08, mid 1/3 9.2± 2.45 and post 1/3 was 9.5±2.04. Thickness of menisci at ant 1/3 was 3.9±1.07, mid 1/3 4.3±1.32 and post 1/3 was 4.8±1.89, 11.9±2.78 is the mean distance between anterior and posterior horns of lateral menisci.

Discussion

In our present study we found the lateral menisci were wider and thicker at post 1/3 followed by mid 1/3 and ant 1/3.

In consistent with our study Ashwini et al found that the posterior third (2.06±9.3 mm) of the lateral meniscus was the thickest part ($p<0.05$) followed by middle third (1.76±0.81 mm) & anterior third (1.41± 0.51 mm) was the least. Width of lateral menisci at ant 1/3, middle 1/3rd & posterior 1/3 are 8.08±1.14mm, 8.52±2.12 mm & 9.36±1.19mm respectively. 83.28±7.464 mm was the peripheral length of lateral menisci & 49±54.92mm was the inner length measured. 6.8±1.99 was the distance between horns of lateral menisci [10]. In contrast to our study, Rohila et al on lateral menisci showed wide mid 1/3 (11.21+2.91) than post1/3(11.03±1.40) and ant 1/3 (9.93±1.71). Thickness wise also mid 1/3 (6.93±1.15) thicker than post 1/3 (6.72±1.12) and ant1/3 (6.40±1.37) [11].

Cadaveric study done on 22 pairs of human menisci found that the peripheral length of lateral menisci was 91.7 ± 9.6 mm, width of the body of lateral menisci was 10.9±1.3 mm [12].

Erbagci et al (2004) performed 174 MRI examinations of the knee with an IT imager. The thickness and width of the anterior horn of lateral meniscus were 4.33±0.98 mm and 8.88±2.3 mm, the thickness and width of the midbody were 4.94±0.99 mm and 8.37±0.83 mm, and the thickness and width of the posterior horn were 5.36±1.03 mm and 9.70±1.69 mm respectively [13].

Kale et al (2006) studied on 22 knee joints of 11 foetal cadavers and measured the mean width of the midpoint of the anterior horn, posterior horn and lateral side of the menisci. They were 0.29, 0.34 and 0.37 cms respectively for the lateral meniscus [14].

Almeida et al (2004) analyzed the morphometric aspects of the lateral menisci of the knee joint. Thickness and width at ant 1/3 were 3.71±1.15mm and 11.86±1.81mm, middle 1/3 were 6.10±1.04mm & 11.97±2.56mm and post 1/3 were 5.29±0.78mm & 11.44±1.07mm respectively. The distance between the anterior & posterior horn of medial lateral meniscus was 12.71±1.84 mm [15]. Dieter Kohn & B. Moreno (1995) measured the peripheral length of the menisci, on 92 knee joints and the value was 111±10 mm for the lateral meniscus [16].

Braz and Silva (2010) in their study on 40 menisci reported the peripheral length of LM was 92.80± 9.36mm. Distance between the anterior and posterior horn of the lateral meniscus (12.55±1.98 mm). With regard to the width of the lateral meniscus, there was no significant difference between the anterior (11.32±1.46 mm), medium (11.16±1.64 mm), and posterior thirds (11.67±1.54 mm). The average thickness of LM was 5.46mm [17].

Kapandji (2000) reports that the distance between the horns of the lateral meniscus are closer together than those of the medial meniscus. Thus LM looks like a ring and MM represents half moon shape. This high proximity between the insertions of the horns of LM would be one of the reasons for the lateral meniscus to be less prone for lacerations [18].

Conclusion

Morphometric parameters of the lateral menisci between right and left knees did not show any significant difference ($p>0.05$). The current study provides added information to database of morphological values of lateral menisci for North Karnataka population for meniscal transplantation. With the above findings, present study proposes that future studies should be undertaken involving assessment of any gender differences in the morphometry of menisci.

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Original Article

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Morphometric Analysis of Human Fetal Renal Development Classified According to Various Gestational Periods

Abraham Ratna Joseph Nayakanti[1], Srinivasan K.R.[2], Subhadra Devi Velichety[3], Koteswary R.[4]

Abstract

Background: Development of human kidney runs through a series of continual and mutually dependentchanges during which kidney obtains its morphological and functional maturity. The evaluation of fetalmorphometrical growth parameters have been subject of increased awareness for theassessment of fetal growth and development and prenatal diagnosis of renal anomalies,geneticcounseling andtreatment of prenatal renal disorders like Wilm'stumor, multicystic renal dysplasia, hydronephrosis. *Materials and Methods:* This work was conducted in different medical institutions in south India. A total of 50 dead fetuses of both sexes in which 20 female and 30 male collected from places with relevant clinical history were utilized for the present study. *Results:* The collected fetal kidneys were observed for their weight, height, thickness and width. The results were analyzed according to gestational age and recorded in separate classified tables. *Conclusion:* The knowledge about fetal kidney morphometry according to their gestational age may be helpful in understanding different congenital and malformations of kidney.

Keywords: Kidney; Fetus; Ultrasound; Fetus.

Introduction

Development of human kidney runs through a series of continual and mutually dependent changesduring which kidney obtains its morphological and functional matuarity.The evaluation of fetalmorphometrical growth parameters have been a subject of increased awareness for the assessment of fetalgrowth and development. It is very important to know the normal developmental anatomy of kidneys in prenataldiagnosis of renal anomalies, geneticcounseling and treatment of prenatal renal disorders like Wilm'stumor, multicystic renal dysplasia and hydronephrosis. Fetal Kidney parameters are most accurate for estimatinggestational age than other biometric indices. Accurate gestational age estimation is very important to anobstetrician for diagnosis of growth disorders, in assessment of wrong dates or forgotten dates and timing ofdelivery either by induction or caesarean section. It is particularly important in high risk pregnancies where in some cases early termination may become necessary as soon as fetus becomes mature [1,2]. The present study wasconducted with the following aims and objectives. To study age related variations in length, width, thickness, number of lobules and weightof the kidneys in fetuses of different gestational ages.

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Materials and Methods

This work was conducted in the department of Anatomy SV Medical College, Tirupati in collaboration with the Departments of Obstetrics and gynecology of govt. Maternity Hospital and Department of nephrology, Sri Venkateswara Institute of Medical Sciences Hospital, Tirupati, AP, India and Vinayaka Missions Kirupanandavariyar Medical College, Salem Poly Clinic, Akshaya Fertility Center and Saraswathi Nursing Home, Salem, TN, India. A total of 50 dead fetuses of both sexes in which 20 female and 30 male collected from places with relevant

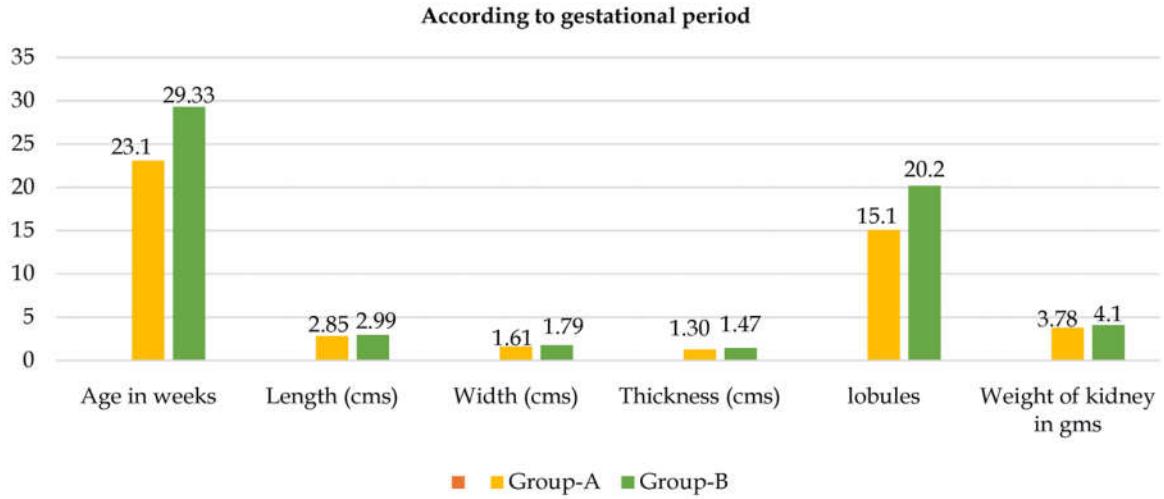
clinical history were utilized for the present study. A special data sheet was designed for recording various parameters observed. The fetal weight, and external visible congenital anomalies were recorded. The fetuses were collected in 10% formalin solution. The fetuses were preserved by injecting 10% formalin solution in to the pleural, peritoneal and cranial cavities. The extremities were preserved by multiple injections technique.

Abdominal cavity of each fetus was opened and the position, shape, and size of the liver stomach, coils of intestine, spleen, pancreas, and large intestine were observed and deviations if any were recorded and appropriate photographs taken. All the above mentioned organs were removed by applying ligatures at the proximal and distal part of the gut to prevent spillage of gut contents. The retroperitoneal organs i.e. kidneys, supra renals, and ureters, abdominal aorta and inferior venecava and their branches were exposed by cleaning the adjacent tissue. The position and immediate relations of kidneys, hilar structures and their arrangement were observed. Both the kidneys with ureters and abdominal aorta with renal arteries upto their entries into the kidney were exposed and were removed from abdominal cavity as a single unit. The weight, length, width, thickness and number of lobulations of the kidneys were recorded and tabulated (Table 1).

Results and Discussion

Group A:

Among 50 fetuses collected for this study, 27 fetuses were in the gestational period between 12 -24 weeks. The average gestational age of this group was calculated as 23.1 weeks.Weight of fetus in this group is ranging from 400gms to 1000gms with a mean weight of 665gms. In this group kidneys weighed from 1.47 to 13.67gms on right side and 1.4 to 14.17gms left side with a mean weight of 3.75gms on right side and 3.81gms on left side. Mean weight of left kidney is slightly higher than the right. Other morphometric parameters such as length, width and thickness were 2.86x1.56x1.3cms and 2.84x1.66x1.29cms on right and left sides respectively. Mean of the number of lobules was 15.2 on right side and 15 on left side. These values



Graph 1: Showing the mean values for morphometric parameters of Group A and Group B kidneys on both sides according to gestational periods

Table 1: Showing the mean values for morphometric parameters of Group A and Group B kidneys on both sides according to gestational periods

Groups	Side	No. of kidneys	Age in weeks	Weight of fetus (gms)	Length (cms)	Width (cms)	Thickness (cms)	Lobules	Weight of kidney (gms)
Group-A	RIGHT	27	23.1	665	2.86	1.56	1.30	15.2	3.75
	LEFT	27	23.1	665	2.84	1.66	1.29	15	3.81
	MEAN	27	23.1	665	2.85	1.61	1.30	15.1	3.78
Group-B	RIGHT	23	29.33	1416.67	2.97	1.75	1.45	20.83	4.06
	LEFT	23	29.33	1416.67	3	1.82	1.48	19.58	4.13
	MEAN	23	29.33	1416.67	2.99	1.79	1.47	20.20	4.10

indicate that there is a little hike in right kidney when compared with the left side mean values in length, thickness and number of lobules. But mean values of width is more on left side than on right side (Table 1 & Graph 1). Our results are in agreement with studies of Nirmalendu Das et al. [3], Konje JC et al. [4].

Group B

Among 50 fetuses collected for this study, 23 fetuses were in the gestational period between 25 - 34 weeks. The average gestational age of this group was calculated as 29.33 weeks. Weights of fetus in this group range from 750gms to 2500gms with a mean weight of 1416.67gms. In this group kidneys weighed from 1.85 to 8.48gms on right side and 1.77 to 7.9gms left side with a mean weight of 4.06gms on right side and 4.13gms on left side. Mean weight of left kidney is slightly higher than the right. Other morphometric parameters such as length, width and thickness were 2.97x1.75x1.45cms and 3x1.82x1.48cms on right and left sides respectively. Mean of the number of lobules was 20.83 on right side and 19.58 on left side. These values indicate that there is a little hike in left kidney when compared with the right side mean values in length, width, and thickness. But the mean value of number of lobules is more on right side than on left side. Overall observations among the 2 groups in this study by the mean values from both right and left side indicate that there is a slight increase in morphometric parameters from Group A to Group B (Table 1 & Graph 1). Our results are in agreement with studies of Shivalingaiah N et al. [5], Sunita V et al. [6], Gupta DP et al. [7].

Conclusion

Gestational age can be calculated using Kidney morphometrical parameters which are proved by various techniques in various fields of Medicine ultrasound and medical imaging and also defining area of the cortex which in turn decides the number of glomeruli present in the kidney. The current study guides the parents of the fetuses for prenatal counselling of NonInsulin dependent diabetes mellitus, other cardiovascular disorders like hypertension and so, because of the low nephron number.

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Original Article

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A Morphometric Study of Proximal Femoral Geometry in Maharashtrian Population and its Clinical Perspective

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Abstract

Background and objectives: The proximal end of femur has been the subject of much attention for Orthopaedic surgeons, as operations on it are one of the commonest among orthopaedic surgical procedures. Fractures of proximal femur are quite common. Internal fixation of these fractures with implants is required for early mobilization of patients. The knowledge of morphology of proximal end of femur is essential for designing of hip replacement implants and for planning before hip arthroplasty. *Methodology:* The study was conducted on 280 adult human femora (136 right and 144 left). Sliding calliper and measuring tape were used for measurement of vertical and transverse diameter of head of femur, head circumference, vertical and transverse diameter of neck of femur and length of neck of femur. Results were analyzed statistically. *Results:* Mean vertical and transverse diameters of head were found to be 40.53±3.51mm and 40.44±3.47mm respectively. Mean circumference of head was 126.33±12.61mm. Mean vertical and transverse diameter of neck were 27.82±2.82mm and 23.20±2.83mm respectively, mean length of neck of femur was 29.35±4.32mm. *Conclusion:* Mean value of all parameters of femur in the present study showed significant differences with those obtained in other populations ($p<0.01$), proving racial and regional variation in femoral geometry. The present study has established valuable parameters which will be of help to forensic experts, anthropologists, orthopaedicians and bio-mechanical engineers in their respective specialities. It will be a guide for future implants design, to provide better fitting implants for the Maharashtrian population.

Keywords: Femur; Morphometry; Implants.

Introduction

The femur, or thigh bone, extending from hip to knee, is the largest, longest, and strongest bone of the human skeleton [1]. The average adult male femur is approximately 48 centimetres in length and 2.84 cm in diameter at mid-shaft level, and has the ability to support up to 30 times the weight of an adult [2]. The neck of the femur is a point of structural weakness and a common site for fracture [3].

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There are morphometric differences in skeletal components among different populations and these variations are related to genetic and environmental factors. Variations in human skeletal measurements also determine the racial characteristics of the populations [4]. Skeletal measurements and shape of bones can offer a guide to clinicians for determination of risk factors for fractures [5]. Fractures are health burden in particular, hip fractures are a major problem for elderly people. The shape of the proximal femur is known to be an important risk factor for hip fracture of femoral neck, regardless of bone mass or bone strength [6].

The proximal end of femur has been the subject of much attention for orthopaedic surgeons as its operation are one of the commonest among orthopaedic surgical procedures [7]. The morphology of proximal femur is essential during designing of total hip replacement implants (THR). Inappropriate implant design and size could affect outcome of the surgery [7].

The purpose of present study was to collect anthropometric data of upper end of femur belonging to Maharashtrian population and to compare these values with those reported in the literature for various ethnic groups.

Materials and Methods

The present study was conducted on 280 adult human femora (136 right and 144 left) available in various medical colleges of Maharashtra. All femora were intact and fully ossified indicating adult bones. Femora with pathological changes were excluded from the study. The Sliding calliper and flexible measuring tape were used for measurement of various parameters of femora.

Head Vertical Diameter (HVD) was measured as the distance between highest and lowest points lying in the equatorial plane of head, by holding it in such a manner that one can see the fovea centralis, calliper was rotated side to side until the maximum diameter was obtained [8]. Head Transverse Diameter (HTD) was measured as a distance between the most laterally projected points on equatorial plane taken at right angle to the vertical diameter of head [8]. Head Circumference (HC) was measured at the same positions as the diameters along the four points marked by marker pen, with the help of flexible measuring tape [8].

Neck Vertical Diameter (NVD) is the minimum diameter of neck of femur in supero-inferior direction. It was measured at the narrowest part of the neck as the distance between superior and inferior border of the neck. Neck Transverse Diameter (NTD) was measured at the narrowest part of the neck as a distance between anterior and posterior surfaces of the neck [8]. Femoral Neck Length (FNL) was measured as the distance between the base of head and the mid-point of intertrochanteric line [8].

All the values were analysed statistically using Statistical Package for Social Sciences Version 17 (SPSS 17) and Smith's Statistical Package (SSP). Proximal femoral morphological dimensions were compared with those reported in other population groups using unpaired-t test.

Table 1: Parameters of right femur

S. No	Parameters	N	Min	Max	Range	Mean	SD
1.	HVD	136	33.90	49.00	15.10	40.57	3.54
2.	HTD	136	34.00	49.00	15.00	40.59	3.47
3.	HC	136	108.00	153.00	45.00	126.50	10.44
4.	NVD	136	22.00	34.54	12.54	27.78	2.78
5.	NTD	136	17.10	31.19	14.09	23.28	2.85
6.	FNL	136	19.85	48.10	28.25	29.15	4.52

Table 2: Parameters of left femur

S.No	Parameters	N	Min	Max	Range	Mean	SD
1.	HVD	144	33.90	49.00	15.10	40.49	3.49
2.	HTD	144	34.00	49.00	15.00	40.30	3.48
3.	HC	144	100.00	153.00	53.00	126.80	10.83
4.	NVD	144	22.00	34.54	12.54	27.86	2.87
5.	NTD	144	18.20	31.19	12.99	23.13	2.82
6.	FNL	144	19.48	39.00	19.52	29.53	4.12

Table 3: Parameters of total femur

S. No	Parameters	N	Min	Max	Range	Mean	SD
1.	HVD	280	33.90	49.00	15.10	40.53	3.51
2.	HTD	280	34.00	49.00	15.00	40.44	3.47
3.	HC	280	10.00	153.00	143.00	126.33	12.61
4.	NVD	280	22.00	34.54	12.54	27.82	2.82
5.	NTD	280	17.10	31.19	14.09	23.20	2.83
6.	FNL	280	19.48	48.10	28.62	29.35	4.32

Results

Parameters of right femur (Table 1). Parameters of left femur (Table 2). Parameters of total femur (Table 3).

Discussion

Six parameters of proximal end of femur were measured and analyzed in the present study. These results were compared with those reported by other authors in different ethnic groups.

Vertical Diameter of Head (HVD)

It varies in different individuals and ethnic groups. The muscular forces acting on the hip joint has powerful effect on moulding the head of femur [9]. This is reflected in variation of its shape and size. Results were compared with those of other authors and summarised in Table 4.

There are statistically significant differences in mean vertical diameter of head of femur of different population groups.

A study in Nepal by AK Mishra et al[4] with mean value of 42.9 mm shows similarity to the present study (mean 40.53 mm) probably because of similar built. Maximum difference in mean was found by Masood Umer et al.[12] in a study done on Pakistan (mean 50.1). Mean vertical diameter of head of femur in present study shows a statistically significant difference with various studies on western population thereby confirming regional variation (graph 1).

Transverse Diameter of Head of Femur (HTD)

In the present study, mean transverse diameter of head of femur is 40.44 mm, which is significantly higher than that in Bangladesh (mean 39.59 mm) reported by Akhtari Afroze [17] and lesser than that in western population. Results were compared with those of other authors and summarised in table 5.

Mean transverse diameter of head of femur in present study shows a statistically significant difference with various studies on different populations thereby confirming regional variation (graph 2).

Circumference of Head of Femur (HC)

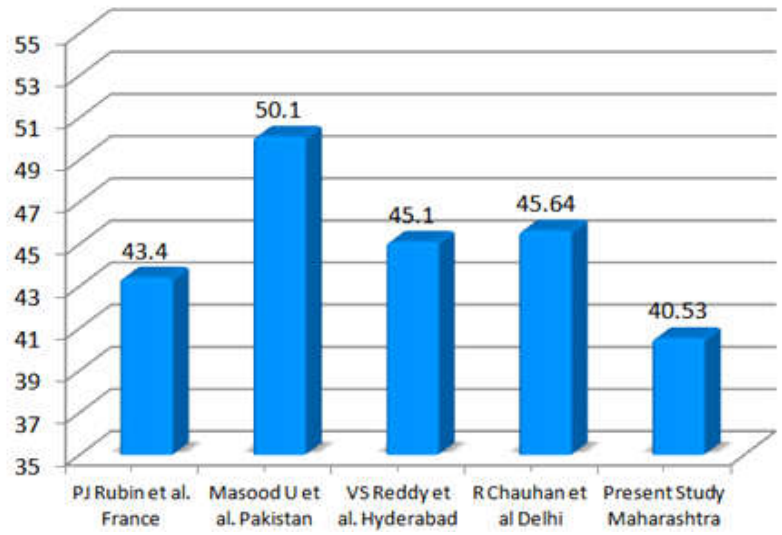
In the present study, circumference of head of the femur (mean 126.33) is lesser than that in Brazil (mean 133.96) ($p<0.01$) as reported by DA Silva et al.[22] and in New Zealand as demonstrated by AMC Murphy [23]. This indicates that western

Table 4: Vertical diameter of head of femur (mm)

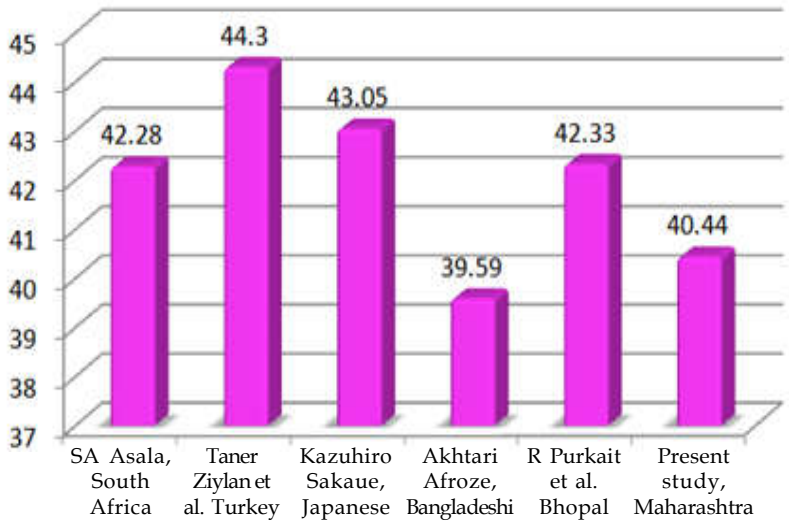
S. No	Name of worker	Sample Size	Mean	SD	p-value
1.	Taner Ziylan et al[10] Turkey	72	43.4	3.2	<0.001
2.	P. J. Rubin et al[11] France	32	43.4	2.6	<0.001
3.	Masood Umer et al[12] Pakistan	136	50.1	3.8	<0.001
4.	M Y Barharuddin et al[7] Malaysia	120	43.62	3.05	<0.001
5.	AK Mishra et al[4] Nepal	50	42.9	3.53	<0.001
6.	V S Reddy et al[13] Hyderabad	74	45.1	3.58	<0.001
7.	R C Siwach et al[14] Rohtak	150	43.95	3.06	<0.001
8.	R Chauhan et al[15] Delhi	36	45.64	3.13	>0.5
9.	T R Deshmukh et al[16] Vidarbha	77	43.30	4.19	<0.001
10.	Present Study Maharashtra	280	40.53	3.51	-

Table 5: Transverse diameter of head of femur (mm)

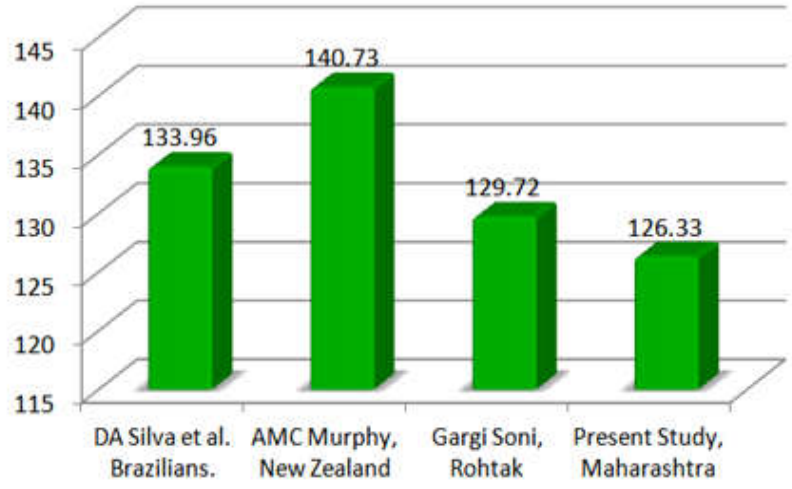
S. No	Name of worker	Sample Size	Mean	SD	p-value
1.	SA Asala[18] South African Whites	260	44.42	2.71	<.001
2.	SA Asala[18] South African Blacks	260	42.28	2.36	<.001
3.	PS Igbigbi[19] Black Malawians	496	48.75	3.38	<.001
4.	Taner Ziylan et al[10] Turkey	72	44.3	3.3	<.001
5.	Kazuhiro Sakaue[20] Japan	64	43.05	2.08	<.001
6.	Akhtari Afroze[17] Bangladeshi	123	39.59	1.26	<0.01
7.	R Purkait, H Chandra[21]Bhopal	124	42.33	2.28	<.001
8.	Present Study Maharashtra	280	40.44	3.47	-



Graph 1: Vertical diameter of head of femur (mm)



Graph 2: Transverse diameter of head of femur (mm)



Graph 3: Circumference of head of femur (mm)

populations have larger femoral head as compared to the femora in present study. The mean circumference of head of femur in Haryana studied by Gargi Soni [24] is close to the present study. The stress across the femoral head of Indian and western population are different which makes the femoral head larger in westerns.

Results were compared with those of other authors and summarised in (Table 6) (Graph 3).

Vertical Diameter of Neck of Femur (NVD): The neck of femur in human is very important and is a functional specialization for erect posture. Results were compared with those of other authors and summarised in (Table 7) (Graph 4). Mean vertical diameter of neck in the present study was found to be 27.82 mm which is similar to that reported by Edie Benedi to Caetano et al. [26] with a mean of 28.69 mm ($p>0.05$). Mean vertical diameter of neck of femur in present study shows a statistically significant difference with various studies on different populations thereby confirming regional variation (graph 4).

Neck Transverse Diameter (NTD): Results were compared with those of other authors and summarised in (Table 8) (Graph 5).

The mean transverse diameter of neck of femur in the present study is 23.20 mm, which is similar to that reported by RC Siwach et al. [14], whereas those documented by C K Chiu et al.[25] in Malaysian population and Taner Ziylan et al. [10] in Turkey are much higher. This shows thinner neck in femora of Maharashtra (graph 5).

Length of Neck of Femur (FNL): The neck of femur is specialised for erect posture in human. In thin built and short individuals neck of femur is also thin and short. It does not have enough space to adjust screws required for fixation of fracture neck.

Table 6: Circumference of head of femur (mm)

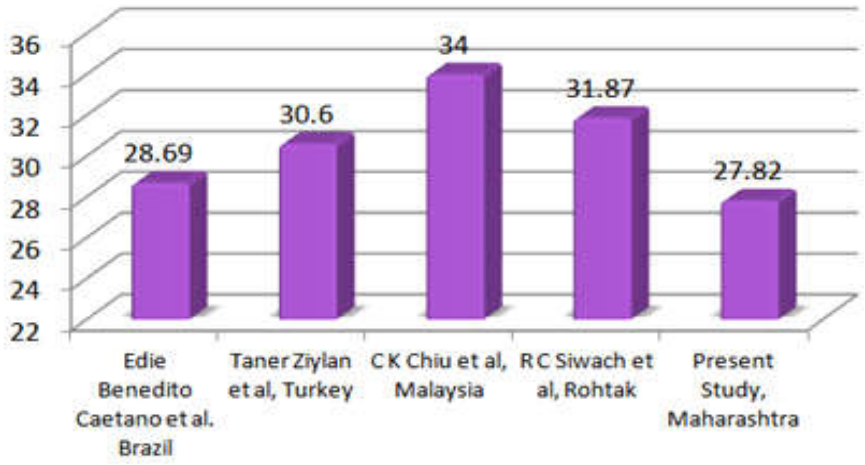
S. No.	Name of Worker	Sample Size	Mean	SD	p-value
1.	DA Silva et al [22] Brazilians	66	133.96	10.2	<0.001
2.	Gargi Soni [24] Rohtak	80	129.72	7.59	<0.05
3.	AMC Murphy[23] New Zealand	85	140.73	6.68	<0.001
4.	Present Study Maharashtra	280	126.33	12.61	-

Table 7: Vertical diameter of neck of femur (mm)

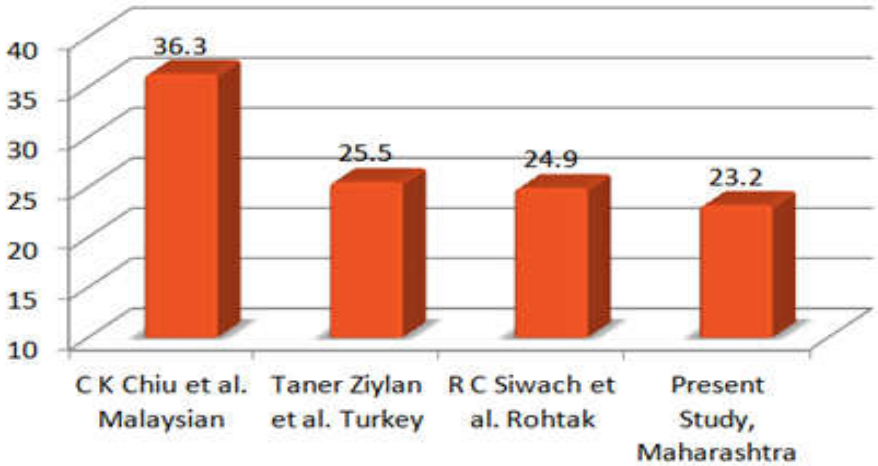
S. No	Name of worker	Sample Size	Mean	SD	p-value
1.	R C Siwach et al[14] Rohtak	150	31.87	2.91	<0.001
2.	AK Mishra et al[4] Nepal	50	33.28	3.22	<0.001
3.	Taner Ziylan et al[10] Turkey	72	30.6	3.0	<0.001
4.	C K Chiu et al[25] Malaysia	100	34.0	3.7	<0.001
5.	Edie Benedito Caetano et al[26] Brazil	34	28.69	2.58	>.05
6.	Present Study Maharashtra	280	27.82	2.82	-

Table 8: Transverse diameter of neck of femur (mm)

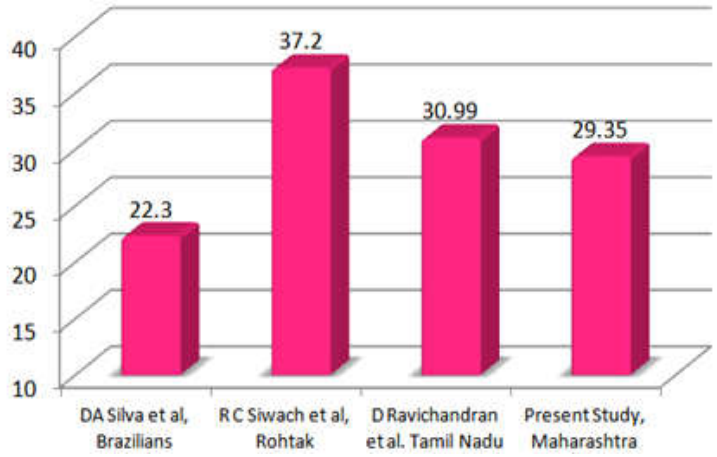
S. No	Name of worker	Sample Size	Mean	SD	p-value
1.	R C Siwach et al[14] Rohtak	150	24.90	2.94	<0.001
2.	C K Chiu et al[25] Malaysia	100	36.3	3.4	<0.001
3.	Taner Ziylan et al[10] Turkey	72	25.5	2.7	<0.001
4.	Present Study Maharashtra	280	23.20	2.83	-



Graph 4: Vertical diameter of neck of femur (mm)



Graph 5: Transverse diameter of neck of femur (mm)



Graph 6: Length of neck of femur (mm)

Table 9: Length of Neck of Femur (mm)

S. No	Name of worker	Sample Size	Mean	SD	p-value
1.	R C Siwach et al[14] Rohtak	150	37.2	4.65	<0.001
2.	DA Silva et al[22] Brazilians	66	22.3	3.3	<0.001
3.	D Ravichandran et al[27] Tamil Nadu	578	30.99	-	-
4.	Present Study Maharashtra	280	29.35	4.32	-

Implants designed for western population occupy almost whole space in the neck and may cause non-union and avascular necrosis.

Study by D Ravichandran et al.[27] in Tamil Nadu (mean 30.99mm) shows similarity in mean value of length of neck of femur found in the present study (Table 9), whereas study by DA Silva et al.[22] Brazil (mean 22.3mm) showed FNL less than that of the present study. Whereas significantly higher values were documented by R C Siwach et al.[14] in Rohtak (mean 37.2 mm) (graph 6).

Conclusion

Six parameters were studied on 280 adult intact femora. All parameters were analysed statistically. Proximal morphological dimensions were compared with those reported by other authors in different ethnic groups.

Mean value of all parameters of femur in the present study showed significant differences with those in different region of India and in western populations proving racial and regional variation in femoral geometry. Thus, such differences should be considered when total hip prostheses are designed. So there is an urgent need for population specific prosthesis. The present study provides valuable parameters which will help forensic experts, anthropologist to deliver excellent performance in their respective specialities. It will provide a guide for future implant designs to provide better fitting implants for Maharashtra.

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Original Article

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Morphological Study of Pedicle of Dry Human Lumbar Vertebrae and its Clinical Significance

Modasiya Umesh P.[1], Yogesh Umraniya[2]

Abstract

Introduction: Strong and large paired lumbar pedicles arise posterolaterally from each body near its upper border.The pedicles important role in transferring weight from neural arch to the vertebral columns. Because of sedentary lifestyle, road site accident and degenerative disorders of spine in old age leads to lumbar instability. So there needs open surgical intervention or sometimes percutaneous pedicle screw fixation may be done to stabilize the vertebrae. So morphometric study of lumbar pedicle helps surgeon for transpedicle screw fixation. The study aimed at measuring the various dimensions of pedicles in lumbar vertebrae and to compare present study with the previous one and discuss its clinical significance. *Material and Methods:* This anatomical study was conducted on 60 lumbar vertebras of undecided sex and age for morphological study. The vertebral columns are collected from anatomy departments of various Medical Colleges of North Gujarat. *Results:* The average width of pedicle at L5 level were most (16.45±2.31mm) and least at L1 level (7.67±2.20mm). The average height of pedicle at L1 level were most (14.80±1.43mm) and least at L5 level (13.83±1.54mm). The average cord length of pedicle at L4 level were most (46.67±4.21mm) and least at L5 level (44.12±3.90mm). *Conclusion:* Morphometric knowledge of pedicles is vital and important for an orthopedic surgeons, anatomist, anthropologists, radiologists and forensic researchers.

Keywords: Pedicle; Lumbar Vertebra; Cord Length.

Introduction

The five lumbar vertebrae are distinguished by their large size and absence of costal facets and transverse foramina. Strong and large paired pedicles arise posterolaterally from each body near its upper border. The fifth lumbar vertebra has a massive transverse process which is continuous with the whole of the pedicle and encroaching on the body. At the level of each disc and foramen, there are two spinal nerves (and their roots) to consider: these are the exiting nerve and the traversing nerve (Macnab & McCulloch 1990). The nerve usually affected at lumbar levels is the traversing nerve, which crosses the back of the disc on its way to become the exiting nerve at the level below. Thus a lumbosacral (i.e. L5/S1) disc prolapse usually compresses the S1 nerve. However, a prolapse may affect the exiting nerve at its own level at cervical and thoracic level [1]. Because of strong and large pedicles of lumbar vertebra make them ideal for transpedicular screw instrumentation. For the stabilization of the lumbosacral spine zindrick described the screw fixation procedure as the method of choice [2]. The screws can be used to fix various devices (plates, rods or wires) to the spine for the purpose of immobilization or fixation in case of various spinal instability such as fracture of vertebra, deformity or degenerative disease. It can also be used in patients who have been laminectomized (Krag et al. 1986) [3]. The success of the technique depends upon the ability of the screw to obtain and maintain purchase within the vertebral body (Zindrick et al. 1986) [4]. This is also depend on other factors like accuracy of choice of screw by surgeon, size of the pedicle and osteoporotic condition of bone. Due to faulty surgical procedure, it may lead to penetration or fracture of cortical bone and pedicle or sometimes misplaced screw lead to various complication such as dural tears, leakage of cerebrospinal fluid and injuries to the nerve roots with [3,4,5]. The horizontal diameter of pedicle helps surgeon to decide the

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screw diameter. The transverse (width) and vertical (height) parameters of pedicle help surgeon in determining the screw path. The cord length of vertebra help surgeon to decide the screw path length. So, the pedicle morphometry becomes important in the selection of most suited pedicle screw. Detailed knowledge of pedicle morphometry is critical for proper placement of the transpedicular screw and to avoid inadvertent penetration of the pedicular wall. The study aimed at measuring the various dimensions of pedicles in lumbar vertebrae. Therefore, the present study was conducted in dry human lumbar vertebrae of north gujarat population and its clinical significance.

Material and Methods

The present study conducted 60 lumbar vertebras of undecided sex and age for morphological study. The vertebral columns are collected from bones of individual dead bodies available in Anatomy departments of various Medical Colleges of North Gujarat. All vertebrae and other bones are fully ossified. All sets of vertebra included in the study are normal. Any vertebra broken, asymmetrical or deformed was excluded from the study. Each vertebra was assigned a serial number. Anatomical measurements were taken on these specimens using a vernier caliper. To avoid error, the measurements were taken on three different occasions and the average values were noted. The following parameters were recorded in our study:

1. Pedicle width (w) in mm at the midpoint of the pedicle- It is the distance between medial and lateral surfaces of pedicle at its midpoint, measured at right angles to the long axis of the pedicle by a sliding vernier caliper. [Figure 1]
2. Pedicle height (h) in mm at the midpoint of the pedicle- It is the vertical distance between superior and inferior border of pedicle at its midpoint with help of sliding vernier caliper. [Figure 2]
3. Chord length (cl) in mm - It is the distance from the most posterior aspect of the junction of the superior facet and the transverse process to the anterior cortex of the vertebral body along the pedicle axis. The mean and standard deviation (S.D.) of each measurement were calculated by using Microsoft Excel and noted for statistical analysis.

Results

In present study, we noted pedicle height, width and cord length. Table 1 show mean and standard deviation of both sides of all lumber vertebras. The average width of pedicle at L5 level were most (16.45±2.31mm) and least at L1 level (7.67±2.20mm). The average height of pedicle at L1 level were most (14.80±1.43mm) and least at L5 level (13.83±1.54mm). The average cord length of pedicle at L4 level were most (46.67±4.21mm) and least at L5 level (44.12±3.90mm). We observed that the height of pedicles maximum at L1 and L3 level, after which it goes on decreasing at two place, one at L2 level

Table 1: Show Mean and SD of width, height and cord length of lumbar vertebras

Vert-ebral No	Width(mm) (Mean± SD) Right	Left	Height(mm) (Mean± SD) Right	Left	Cord length(mm) (Mean± SD) Right	Left
L1	7.57 ± 1.20	7.76 ± 1.27	15.04 ± 1.47	14.57 ± 1.39	45.37 ± 3.12	44.42 ± 2.89
L2	8.09 ± 1.88	7.92 ± 1.54	14.10 ± 1.58	14.24 ± 1.71	46.68 ± 2.69	45.32 ± 2.93
L3	9.46 ± 2.08	9.32 ± 1.63	14.57 ± 1.45	14.44 ± 1.34	46.88 ± 3.61	45.62 ± 3.83
L4	12.08 ± 2.20	11.41 ± 2.21	14.01 ± 1.29	14.28 ± 1.40	47.47 ± 3.94	45.87 ± 4.46
L5	16.84 ± 3.46	16.06 ± 3.50	13.91 ± 1.23	13.75 ± 1.85	44.81 ± 3.22	43.42 ± 4.56

Table 2: Comparison of means of the various parameters in lumbar vertebras with other study

Study	L1		L2		L3		L4		L5	
	Height (mm)	Width (mm)	Height (mm)	Width (mm)	Height (mm)	Width (mm)	Height (mm)	Width (mm)	Height (mm)	Width (mm)
Berry et al[7]	15.6	7	15.3	7.5	14.5	9.2	13.1	10.4	13.7	10.7
Zindrick et al[8]	15.4	8.7	15	8.9	14.4	10.3	14.8	12.9	14	18
Olsewski et al[9]	17	9.5	16	9.6	16	11.7	16.4	14.7	17.4	21.1
Mitra et al[10]	15.68	7.05	15.27	7.85	15.03	9.01	14.79	11.6	15.67	16.19
Yuvraj rajput[11]	14.2	7.2	14.2	7.9	14.2	9.1	14.9	10.5	19.2	12
Takahiro Makino et al[12]	11.89	5.46	10.44	5.76	10.23	7.25	9.36	9.01	8.95	12.86
Present study	14.80	7.66	14.17	8.00	14.50	9.39	14.15	11.74	13.83	16.45

Table 3: Comparison of means of cord length with other study

Study	Mean Cord length (mm)
Mitra SR et al[10]	46.55
Ebraheim et al[13]	48.87
Alon Wolf et al[14]	46.73
Acharya S et al[15]	47.68
Dhaval K. Patil et al[16]	Right: 44.78; Left: 44.65
Present study	Right: 46.24; Left: 44.93

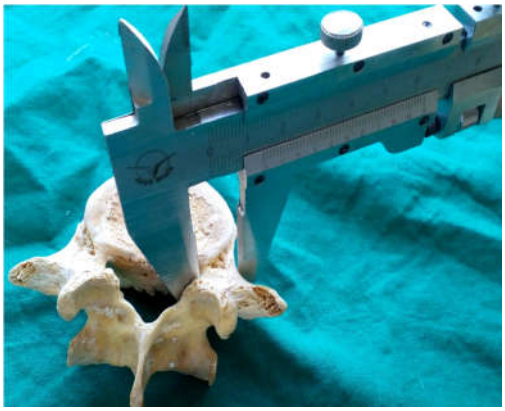

Fig. 1: Show width of pedicle measurement by Vernier Caliper

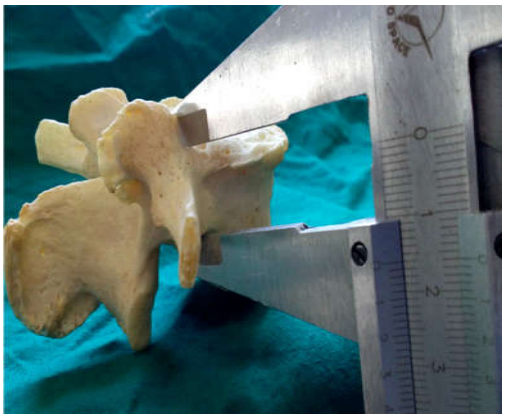

Fig. 2: Shows height of pedicle measurement by Vernier Caliper

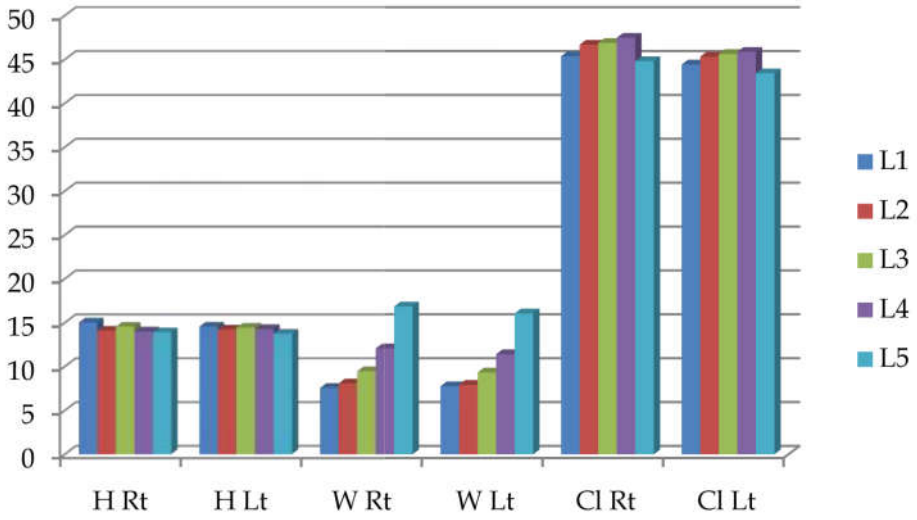

Fig. 3: Shows graphical representation of all parameter in lumbar vertebras

and another at L4 & L5 levels for both sides. The width for pedicles increases from L1 to L5 in both sides. The cord length of pedicle least at L5 level and most at L4 level [Figure 3].

Discussion

Lumbar vertebras are commonly involved in road site accident, degenerative disorder and tumors in vertebral bodies. So it may require surgical intervention to overcome the defect and provide stability to lumbar vertebras. For transpedicle screw fixation, various parameter of pedicle help surgeon in instrumentation of actual size of screw and placement of screw in proper direction to avoid injury of neurovascular bundle. Anatomical variations can make screw placement challenging and retrospective studies have demonstrated that even in experienced hands, pedicle wall violations can occur in up to 29% of cases [6]. Measurement of pedicles can be taken with help of computed tomography (CT) scans, Magnetic Resonance imaging scans, plain radiographs, and direct

specimen measurements such as we measured in present study. In present study we observed, pedicle width increase from L1 to L5 level, which were similar to studies conducted by Berry et al.[7], Zindrick et al.[8], Olsewski et al[9], Mitra et al.[10], Yuvraj rajput[11], Takahiro Makino et al. [12]. We observed that the height of pedicles maximum at L1 and L3 level, after which it goes on decreasing at two place, one at L2 level and another at L4 & L5 levels. These finding were in contrast to study conducted by Zindrick et al., they observed that the height of pedicles maximum at L1 and L4 level, after which it goes on decreasing at two place, one at L2 & L3 levels and another at L5 levels for both sides [Table 2].

The cord length of vertebra help surgeon to decide the actual size of screw used in transpedicle screw fixation. In present study, we observed the mean cord length of lumbar vertebra was 45.58 mm, which was less as compared to study conducted by Mitra SR et al [10], Ebraheim et al. [13], Alon Wolf et al. [14], Acharya S et al. [15] [Table 3]. In transpedicle screw fixation method, the screw is passed through cord length. Because the success of this technique depends strength of vertebral body and selection of actual size of screw. Therefore, morphometric data concerning pedicles are useful in preoperative planning and also in designing pedicle screws and other implantable devices.

Conclusion

The present study provide qualitative information regarding morphometry of lumbar pedicle in north Gujarat population. These findings may be helpful for orthopedic surgeons, anatomist, anthropologists and forensic researchers. Detailed knowledge of pedicle morphometry is critical for proper placement of the transpedicular screw and protect the neurovascular structure by avoiding inadvertent penetration of the pedicular wall.

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Original Research Article

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Endocrine Ramifications of Anatomical Lesions of the Pituitary Gland

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Abstract

Context: The pituitary gland or hypophysis cerebri is a neuroglandular body regulating the secretory activity of a host of other endocrine glands and tissues of the body. It lodges in the hypophyseal fossa of the sella turcica in the body of the sphenoid bone of the skull and is easily identified radiologically. To comprehend the functional disturbances caused by pituitary gland it becomes imperative to correlate it anatomically. *Aims:* In this study we aim to highlight through case vignettes how an early recognition of anatomical lesions in the pituitary can influence the treatment plan in a patient presenting with a plethora of endocrine disturbances. *Methods and Material:* Interesting and illustrative cases were chosen from the endocrine clinic of a tertiary care centre. Both outpatient and inpatient cases were included for the study. *Results:* In this article through illustrative cases we demonstrate how anatomical lesions in the pituitary gland can affect other essential hormones and electrolytes namely sodium. The case vignettes will help the physician to interpret the not so common abnormalities of the thyroid function tests and also take early corrective measures to prevent mortality and morbidity in patients. *Conclusions:* The cases will impress upon the physician that all pituitary masses need not be operated and hence will prevent unnecessary surgical intervention. It will also help the anatomist to teach applied anatomy to students who will then relate to the endocrine emergencies and severe electrolyte abnormalities as a result of anatomical abnormalities in the pituitary gland.

Keywords: Pituitary Gland; Hyponatremia; Panhypopituitarism; Pituitary Adenoma; Pituitary Lesions; Hypothalamic Hamartoma.

Introduction

The pituitary gland, or hypophysis cerebri, is a reddish-grey, ovoid body, about 12 mm in transverse and 8 mm in anteroposterior diameter, and with an average adult weight of 500 mg. It is continuous with the infundibulum, a hollow, conical, inferior process from the tuber cinereum of the hypothalamus. It lies within the pituitary fossa of the sphenoid bone, where it is covered superiorly by a circular diaphragma sellae of dura mater [1]. The endocrine glands and the hormones they release are essential for the normal body homeostasis. The hormones released by these glands help in the brain development, attaining puberty, achieving target height, child bearing, maintaining the fluid and electrolyte homeostasis of the body and participate in almost all bodily functions. Developmentally the pituitary gland consists of a cellular portion derived from Rathke's pouch known as Anterior pituitary/ Adenohypophysis and a neural portion derived from a downgrowth from the diencephalon known as Posterior pituitary/Neurohypophysis. Adenohypophysis has two types of acidophils namely somatotrophs and mammotrophs along with three types of basophils namely gonadotrophs, thyrotrophs and corticotrophs [2]. The neurohypophysis contains unmyelinated nerve fibres, fenestrated plexus of blood capillaries and pituicytes. The hypophysiotropic area of hypothalamus via tubero-infundibular tract conveys releasing or inhibiting hormones to the adenohypophysis which is further regulated by a feedback mechanism in response to the level of circulating hormones from the target endocrine organs.

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The neurohypophysis supplied by hypothalamo-hypophyseal tract, acts as storage and releasing centre for vasopressin and oxytocin synthesized by supra-optic and paraventricular nuclei of hypothalamus respectively [3].

The sellar region is an anatomically complex area bounded by sphenoid sinus anteroinferiorly, the paired cavernous sinuses laterally, the suprasellar cistern and its contents, diaphragma sellae and hypothalamus superiorly, and the dorsum sella and brainstem posteriorly [4].

Anatomical defects in these glands have far reaching and sometimes life threatening consequences. In this article through illustrative cases we demonstrate how anatomical lesions in the pituitary gland can affect other essential hormones and the electrolytes such as sodium.

The case vignettes will help the physician to interpret the not so common abnormalities of the thyroid function tests and also take early corrective measures to prevent mortality and morbidity in patients.

Thus we aim to highlight that we need to expand our assessment of endocrine disturbances in the background of anatomical defects in the pituitary which is reflected in varied forms necessitating intervention which may not be surgical always.

Materials and Methods

Interesting and illustrative cases were chosen from the endocrine clinic of a tertiary care centre. Both outpatient and inpatient cases were included for the study. Informed consent was taken in preformed consent format to ensure that individuals understand the purpose, risk and benefits of research studies. Out of a myriad of cases presenting in the endocrine clinic of a tertiary care hospital in central India we are exclusively presenting those rare cases in which mere treatment of symptomatology arising from hormonal imbalance at the time of admission alone does not suffice. The final selection of these cases was made only after identifying pituitary lesion as the underlying etiology.

Results

Selected cases with case history, examination and investigation findings with final diagnosis is discussed subsequently with its anatomical correlation.

Case 1

History:

A 70 yrs female presented with recurrent admissions for hyponatremia in August 2017. With each admission she was managed with hypertonic saline and discharged on Tolvaptan (a selective vasopressin receptor 2 antagonist). On reviewing the previous years' papers we came across a thyroid function report dated July 2015 which suggested secondary hypothyroidism i.e. low thyroid hormones with a low or normal TSH.

A Thyroid function test was repeated and an 8 am cortisol was done. The 8 am cortisol was low (Fig. 1) suggesting hypocortisolism and the thyroid functions again suggested secondary hypothyroidism. The results suggested Panhypopituitarism. A MRI of the pituitary was advised.

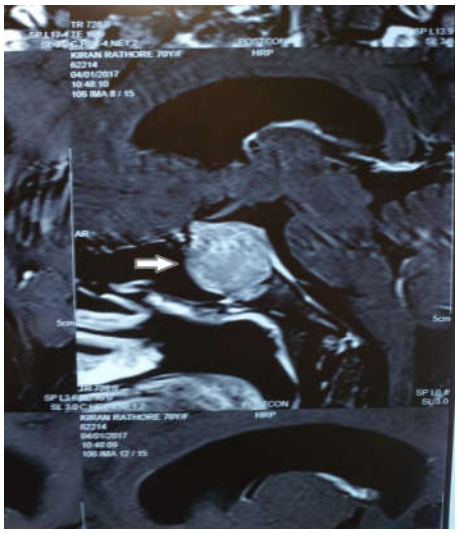

Fig. 1: A MRI of the pituitary was advised

The MRI revealed a pituitary macroadenoma. This was the reason for the secondary hypothyroidism and hypocortisolism.

The patient subsequently underwent a transphenoidal pituitary surgery. She is on steroid and thyroid hormone replacement and is doing well.

We must look out for abnormal thyroid function tests as they may just give you the clues to the aetiology of hyponatremia and also prevent life threatening complications. In the present case the hyponatremia was due to panhypopituitarism due to pituitary mass.

Case 2

History:

A 68 year old male presented with seizures and hyponatremia. The patient had recurrent admissions for the same over the past 2 years.

We were called to investigate the cause of hyponatremia. The thyroid function tests done again showed a picture suggestive of secondary hypothyroidism. Low serum sodium and thyroid function tests suggestive of secondary hypothyroidism i.e. low TSH and low free T4.

An X ray of the sella was advised to look for the sellar size. Fig. 2.

The X ray revealed a deep and large sella suggestive of a pituitary mass.

The MRI revealed an empty sella leading to

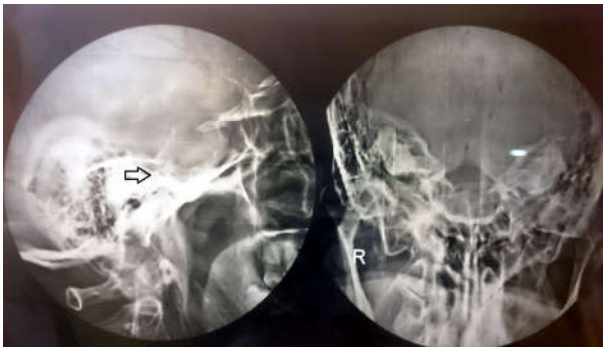

Fig. 2:

secondary hypothyroidism and the resultant hyponatremia.

Case 3

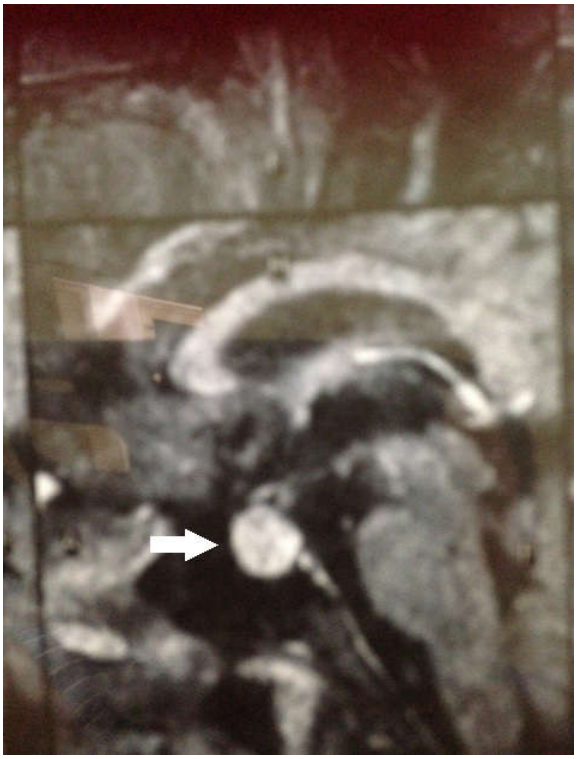

Fig. 3:

History:

A 32 year old male presented to us with infertility, loss of libido and lethargy.

He was investigated to have a high prolactin, low testosterone and a TSH of more than 150 mIU/ml.

A physician looking at the high prolactin got an MRI done which revealed a pituitary macroadenoma.

The patient was referred to us for the pituitary mass and the high prolactin. Fig. 3.

Now the interesting thing is the interplay the hormones have and their effect on the other hormones. The TRH has a molecular mimicry with the prolactin; so once TSH rises the prolactin witnesses a moderate rise too. Also in severe primary hypothyroidism there is a hypertrophy of the pituitary thyrotrophs leading to a pituitary hyperplasia and may be misinterpreted for a pituitary macro or a microadenoma. These patients don't require surgery but only an appropriate thyroid hormone replacement. The hyperplasia just melts away, just as in our patient. Fig. 4.

With the resolution of the hyperplasia, the libido improved, the testosterone level normalised and subsequently the patient fathered a child.

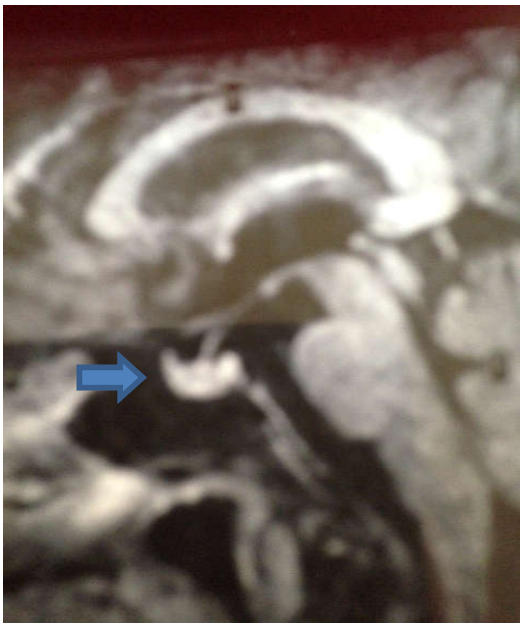

Fig. 4:

Case 4

History:

A 2 year old male child presented with history of early development of secondary sexual characters. The child was a product of full term normal vaginal delivery with normal psychomotor milestones.

Examination: Testicular volume of 8 ml bilaterally Stretched penile length of 6.5 cm (both high for his age).

Investigations: X–Rays of both hands for bone age determination (Fig. 5). The bone age of the child as determined by Greulich– Pyle atlas was 7 years as against the chronological age of 2 years. The advanced bone age signifies the rapidly progressive maturation of skeletal system due to systemic exposure to gonadal steroids.

GnRH analogue stimulation test confirmed central sexual precocity.

MRI scan of the brain revealed a hypothalamic hamartoma. (Fig. 6)

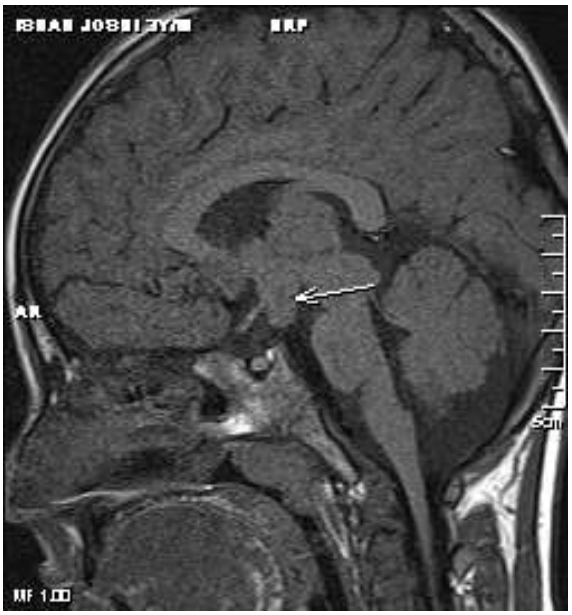

Fig. 5: Hypothalamic hamartoma

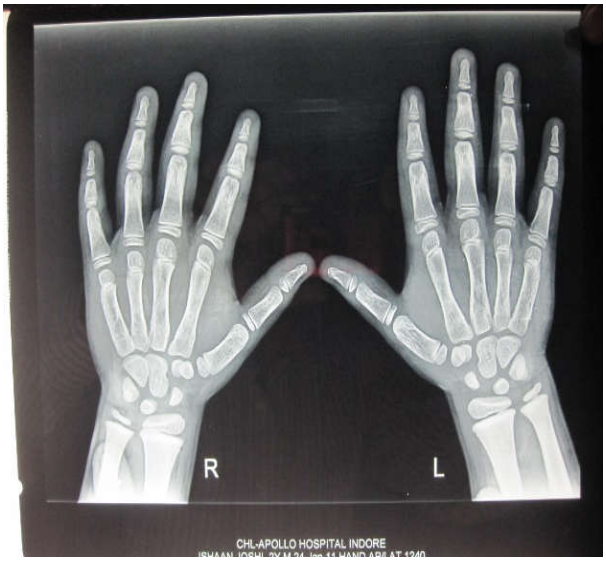

Fig. 6:

Diagnosis: Hypothalamic Hamartoma causing central sexual precocity.

Case 5

History:

A 14 year boy was referred to us with short stature, nystagmus,headache, poor scholastic performance.

The child had previously been investigated by the neurologist and an MRI of the brain had been done which revealed a pituitary mass.

The child was investigated and was found to have a TSH of more than 150 mIU/ml.

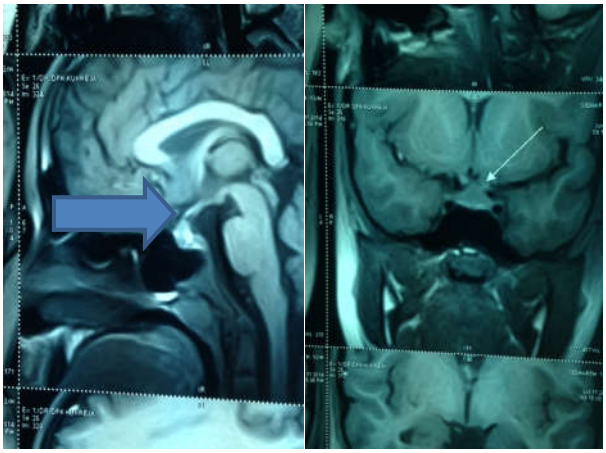

Fig. 7: Pituitary Mass in sagittal and coronal sections of the MRI

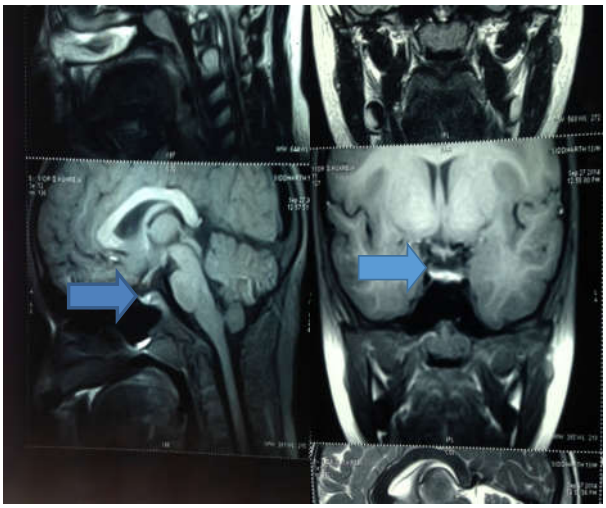

Fig. 8: Coronal and sagittal MRI sections showing complete resolution of the pituitary mass in the second MRI

Levothyroxine replacement therapy was started in appropriate doses.

A repeat MRI was performed 5 months after the treatment.

Discussion

The above cases illustrate how an alert physician can diagnose early the life threatening consequences of anatomic lesions of the pituitary. Hyponatremia is a common finding both in the inpatient and outpatient departments and results in significant morbidity and mortality [5]. Correcting the low sodium merely by hypertonic saline and giving tolvaptan for a few days and not interpreting the thyroid function tests and consequently not correcting the underlying etiology of hyponatremia can lead to poor outcomes for the patient as in our first two illustrative cases [6,7]. Both the cases had hyponatremia and thyroid function tests suggestive of secondary hypothyroidism but were initially not picked up for almost a year and a half as in the first case. They both were symptomatically treated for hyponatremia resulting in recurrent admissions and seizures. Once the cause was evaluated and treated by transphenoidal surgery in the first case (pituitary macroadenoma) and appropriate hormone replacement in the second case (empty sella), they have been totally asymptomatic and carrying on with their activities of daily living.

Not all pituitary masses need surgery and in fact surgery in cases of pituitary hyperplasia due to severe hypothyroidism can be catastrophic. The (Cases 3 and 5) [8] demonstrate how simple levothyroxine replacement can lead to complete resolution not only of the pituitary masses but also the associated endocrine abnormalities. The case 3 showed how the enlarged pituitary due to thyrotroph hypertrophy led to infertility, low libido, low serum testosterone and a high prolactin. The high prolactin was due to the molecular mimicry of TRH and prolactin [9]. Once the adequate levothyroxine replacement was done, the patient not only had normal sperm count and libido but even fathered a child after a year. Case 5 illustrates the need to evaluate short stature methodically and not to rush into surgical intervention of the pituitary. There have been cases where the hyperplasia of the pituitary has been operated upon with disastrous consequences. The child was referred to us and again appropriate thyroid hormone replacement led to complete resolution of the pituitary mass and rapid height gain and normal scholastic performance of the child.

The 4th case is a rare case of isosexual precocity in a 2 year old male child. The child had hypothalamic hamartoma leading to precocity. These tumors may or may not be operated upon depending upon the size and mass effects of the tumor. The hamartoma is a developmental malformation in the region of the tuber cinereum and mamillary bodies [10]. Children present with precocity and gelastic seizures. GnRH therapy can regress the precocity and occasionally they may require surgical removal.

MRI techniques in diagnosing pituitary lesions have witnessed a rapid evolution, ranging from non-contrast MRI in late 1980s to contrast-enhanced MRI in mid-1990s. Introduction of dynamic contrast-enhanced MRI has further refined this technique in diagnosing pituitary microadenomas [11].

Conclusion

The interplay of endocrinology and anatomy is essential to understand for the appropriate management of disorders of electrolyte imbalances and hormone disorders. Hyponatremia is one of the commonest electrolyte disorders and results in significant mortality and morbidity. It is multifactorial in origin and one important cause is endocrine abnormalities. Early diagnosis and treatment saves lives and recurrent hospital admissions. The physician and the endocrinologist have to work in tandem to manage cases as has been shown in the above examples. The applied anatomy of the pituitary and sella is important and must be taught to students which then forms the basis for future learning in clinics.

Key Messages

Anatomical lesions of pituitary have varied clinical outcomes that need to be taught and identified by medical professionals in an extensive manner as they are crucial in planning the appropriate treatment strategy.

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Case Report

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Biceps Anatomical Aberration in a Cadaveric Study

Vijay Ananth K.

Abstract

In a routine cadaveric dissections in a cadaver the short head of Biceps Brachii tendon (SHBT) showed bifurcated in attachment with the belly of the Pronator Teres muscle seen along with its usual course of attachment with the radial tuberosity. This was seen bilaterally on both the upper limbs in the same body during the anatomical dissection. Here the biceps brachii was originating from the long head from the supraglenoid tubercle from the capusular joint and the short head from the coracoid process of scapula.

Keywords: Biceps Brachii and Pronator Teres Muscle; Extrarticular Insertion; Cadaver.

Introduction

In the upper extremity the anterior compartment forms the flexor group muscles of which along with the coracobrachialis the Biceps Brachii plays a major role in flexing the arms and the elbow joint. It compensates the action with the Triceps Brachii the posterior compartment muscle of the brachium which forms the extensors.

It is a large fusiform muscle of that compartment [3,8] and a primary supinator of the forearm. Biceptal aponeurosis, a triangular band formed from the deep fascia originates from the biceps tendon. This aponeurosis gives protection to the cubital fossa. A third head is also reported seen posterior to the brachial artery [8].

It originates from long and short heads from supraglenoid tubercle and coracoids process of scapula respectively.

And both the heads converge with the two belles and gets inserted into the posterior part of the tuberosity of radius bone [9].

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Fig. 1: Rt. Side Arm

Figure 1 shows Biceps Brachii in the front of forearm and the Cubital fossa below.

Red arrow shows the LHBT inserting into the radial tuberosity.

Green arrow shows the SHBT and its extrarticular insertion was seen in the pronator teres muscle which is the medial border of Cubital Fossa (Fig. 1).

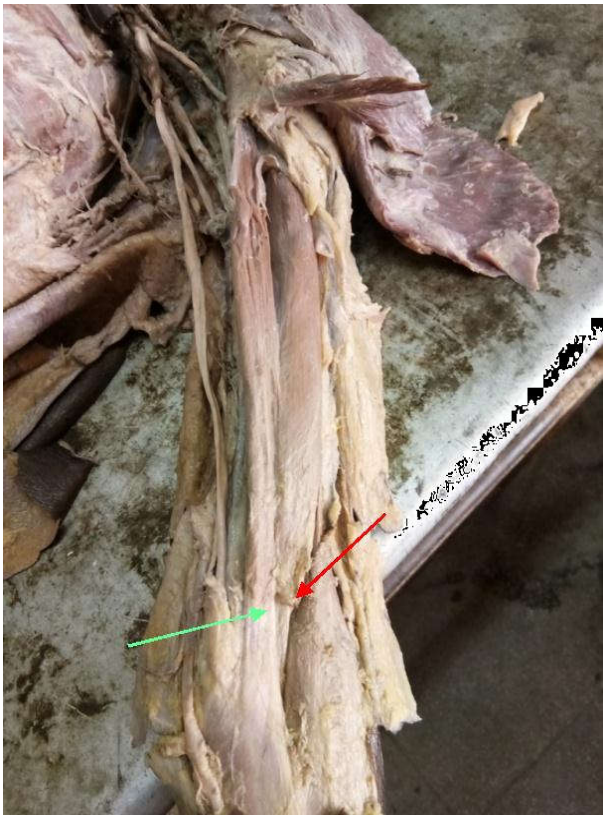

Fig. 2: Lt. Side Arm

Figure 2 shows Biceps Brachii in the front of forearm and the Cubital fossa below.

Red arrow shows the LHBT inserting into the radial tuberosity.

Green arrow shows the SHBT and its extrarticularinsertion was seen in the pronator teres muscle which is the medial border of Cubital Fossa (Fig. 2).

Case Report

In the year 2016 a male cadaver was procured to the Dept. of Anatomy, National Institute of Homoeopathy for the dissection purpose regarding teaching and training the undergraduate students which was procured from the R.G. Kar Medical College through the Director of Medical Education. It is know that such anatomical aberration may be seen due to any congenital or as anatomical anomalies. The short head of Biceps Brachii and the long head originated from their respective course but this extrarticular insertion was seen in the pronator teres muscle for the SHBT but the LHBT got inserted into the tuberosity of radius as usually. The arterial and nerve supply was normal.

Discussion

Different origin was noted in some case studes like The supernumerary head was a bulky muscle belly and originated from the medial lip of the intertubercular groove [1]. The absence of the long head of the biceps (LHB) tendon as reported in the fourth case of bilateral congenital anamaly of the LHB tendon under clinical studies conducted by using Ultrasonography (US) and magnetic resonance (MR) when the patient experienced anterior shoulder pain at rest that exacerbated with overhead activities. The pain was moderate for months but worsened in the last few weeks, specially seen after sports activity in another study by Rego Costa and et al. [6].

In one particular study 74 cadavers were dissected and observed in one year based on its variations in shape and insertion of the Biceps Brachii were found in 10 out of 74 cadavers (13,5%). In which 20 arms of the 10 cadavers, 14 had variations, thus, in 148 analyzed arms, only 9,4% varied. Bilateral variation occurred in 4 arms, and 2 of them were symmetric. Eight different types of variations were found in Brazilians as per Denize Augusto da Silva and others [4].

Bergman, Thompson and Afifi reported that the two heads of biceps brachii muscle may be totally separate or fused and either head may be absent. In the absence of long head, the tendon may be found arising from the bicipital groove, one of the tubercles of humerus, the capsule of then shoulder joint or the tendon of pectoralis major [2]. In a similar study by Hyman and Warren too came across an extra-articular origin of the long head of biceps brachii [7]. Sharadkumar Pralhad Sawant and others observed that in undergraduate dissections a male donated cadaver showed that the short head of the biceps brachii muscle got inserted into the radial tuberosity of the radius separately. The long head got inserted into the radial tuberosity and bicipital aponeurosis though the orgin was as usual [5]. In a detailed study by Subhalakshmi Wahengbam and others in a 35 adult cadavers which were dissected and observed for variations in the origin and insertion of biceps brachii muscle bilaterally. Among the 70 arms studied, three had 3-headed biceps brachii, 2 on the left and 1 on the right side.

All the third heads were of humeral origin, which inserted into the radial tuberosity by a common tendon with the long and short heads [10]. All such anomalies can be visualised during the daily activities or in extreme physical work but in the present work as the Cadaver was procured from the mortuary no details

of the case history is recorded or was available. Further it is possible the individual may have some discomfort in flexing the elbow but that must have substantiated with the Pronation muscles during his life.

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[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.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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