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Study of Numbers of Papillary Muscles in Left Ventricle of Fetal Hearts of Gestational Age from 14 to 40 Weeks

Ashish E Khokhariya¹, Kuldeep N Suthar²

Abstract

Introduction: Normal mitral valve function depends on pillars of the trabeculae carnea represented by the papillary muscles. Knowledge of numbers of papillary muscles in anterior and posterior groups of papillary muscles is important because it is one of the components of mitral valvar complex and also for the restoration of normal physiological function of mitral valve which required resenctioned and stitching of papillary muscle, in case of injury and dysfunction of papillary muscle which lead to mitral regurgitation. **Materials and Methods:** Thirty formalin preserved fetal hearts at gestational age from 14 to 40 weeks were dissected through midline thoracotomy and cutting open the pericardial sac. The numbers of papillary muscles in anterior and posterior groups of papillary muscles in left ventricle were observed and recorded after an incision from the apex of heart along the left border and extending up to the left atrium. **Result:** The single papillary muscle in the anterior group of papillary muscles was in 21 (70%) fetuses, 2 anterior papillary muscles in 8 (26.7%) fetuses and 3 anterior papillary muscles in 1 (3.3%) fetus. The single papillary muscle in posterior group of papillary muscles was seen in 25 (83.3%) fetuses, 2 posterior papillary muscles in 4 (13.3%) fetuses, 3 posterior papillary muscles in 1 (3.3%) fetus. **Conclusion:** This study helps to understand the importance of papillary muscle in mitral valve complex and also to cardiothoracic surgeons for the surgery on mitral valve in case of mitral valve regurgitation.

Keywords: Papillary muscles; Mitral valve; Fetal heart; Left ventricle.

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Introduction

Papillary muscles represent the pillars of trabeculae carnea. Trabeculae carnea i.e., papillary muscles of left ventricle are similar to right ventricle, but are well developed. It presents two groups of papillary muscles anterior and posterior. It attached to cusp of mitral valve by the chordae tendinae.¹ The mitral valvar complex comprises the mitral

orifice and its annulus, valvular leaflets, chordate tendinae and papillary muscles.² Papillary muscle is one of the components of the mitral valvar complex, so knowledge of variation in the form of number of papillary muscles is important to the Cardiac surgeon for performing various operative procedures on the mitral valve.

The function of papillary muscles is to prevent the prolapse of AV valve into atria during ventricular systole. So proper functioning of these muscles maintains the integrity of mitral valve, abnormalities of it ranges from a life-threatening emergency (muscle rupture) to an echocardiographic finding of doubtful clinical significance (muscle calcification).³ So, dysfunction and injury to papillary muscles leads to complications of mitral valve like prolapsed and mitral regurgitation⁴ and consequently leads to myocardial infarction and acute cardiac failure.

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Single papillary muscle is usually associated with other malformations like supramitral valve ring, diffuse subaortic stenosis, coarctation of aorta,⁵ valvular aortic stenosis, ventricular septal disease and valvular pulmonary stenosis.⁶ Parachute mitral valve is a congenital condition characterized by only one papillary muscle to which all mitral chordae tendinae are attached. The resultant mitral valve is usually stenotic,⁵ but it may be purely incompetent or may function normally.⁶ An increased number and size of the papillary muscles, as well as their malformation, may cause left ventricular outflow tract obstruction and mitral regurgitation.⁷

Papillary muscles serve an important landmark for the surgeons to reach the commissures. It is especially true of the anterolateral papillary muscle which usually has only one belly.⁸ In all surgical procedures, the two papillary muscles are stitched together to correct the disorder, or one of the heads of the anterior papillary muscle is resected and then stitched together with the posterior papillary muscle. If there are more papillary muscle bellies, the number of options to decide the direction and degree of realignment also increases, thereby facilitating the restoration of normal physiological function.⁷ Therefore, it is important to have knowledge of the variation in the form of number of papillary muscles.

Materials and Methods

This study was conducted in B.J. Medical College, Ahmedabad, in the Department of Anatomy after obtaining permission from the ethical committee. These fetuses of both the sexes were collected from the Department of OBS & GYN, B.J. Medical College, Ahmedabad with due permission from concerned parties and authorities. Any fetus which showing gross maceration was excluded from the study. Among fetuses, 17 female and 13 male were there. The heart specimens were preserved by injecting 10% formalin into umbilical vein. Age of the fetuses was determined from LMP & USG report of Mother. Thirty fetal hearts at gestational age from 14 to 40 weeks were dissected. Hearts were removed

with a midline thoracotomy and cutting open the pericardial sac. Now Left ventricle of all hearts was cut opened with an incision from the apex of heart along the left border and extending up to the left atrium. Left ventricular chamber was washed with running tap water to visualize the papillary muscles. The number in anterior and posterior groups of papillary muscles in left ventricle was observed and recorded.

Inclusion Criteria

Aborted fetuses of gestational age 14 to 40 weeks.

Exclusion Criteria

- Patients refusing to give consent.
- Aborted fetuses below the gestational age of 14 weeks and macerated fetuses.

Results

The numbers of papillary muscles in anterior and posterior groups are presented in Table 1.

We observed that single papillary muscle in anterior group of papillary muscles was most common in majority of hearts and single papillary muscle in posterior group of papillary muscles was also most common in majority of hearts in our study (Table 1). Figure 1 shows 2 anterior papillary muscles and 1 posterior papillary muscle. Figure 2 shows 3 anterior papillary muscles and 2 posterior papillary muscles. Figure 3 shows 1 anterior papillary muscle and 2 posterior papillary muscles.

In our study, the single papillary muscle in the anterior group of papillary muscles was most common in 21 (70%) fetuses. 2 anterior papillary muscles were seen in 8 (26.7%) fetuses and 3 anterior papillary muscles in 1 (3.3%) fetus, but we could not see four papillary muscles in the anterior group (Table 1). The single papillary muscle in posterior group of papillary muscles was seen in 25 (83.3%) fetuses, 2 posterior papillary muscles were seen in 4 (13.3%) fetuses, 3 posterior papillary muscles in 1 (3.3%) fetus (Table 1).

Table 1: Numbers of Papillary Muscles in Anterior and Posterior Groups in Left Ventricle

Number of Papillary muscles	Anterior group of papillary muscles	Posterior group of papillary muscles
1	21 (70%)	25 (83.3%)
2	8 (26.6%)	4 (13.3%)
3	1 (3.3%)	1 (3.3%)
4	0	0
Total	30	30

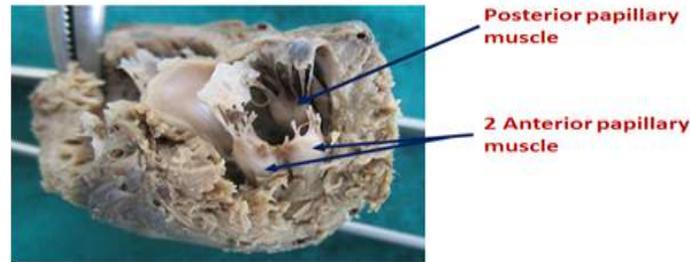


Fig.1: 2 anterior papillary muscles and 1 posterior papillary muscle of left ventricle.

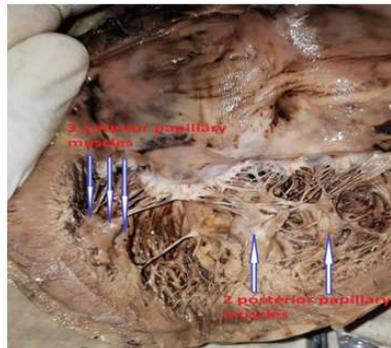


Fig. 2: 3 anterior papillary muscles and 2 posterior papillary muscles of left ventricle.

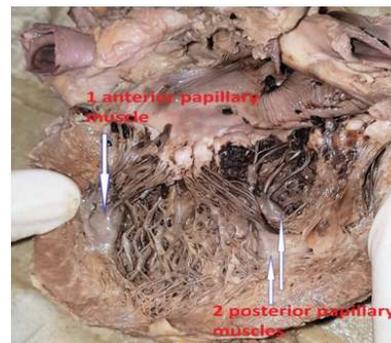


Fig. 3: 1 anterior papillary muscle and 2 posterior papillary muscles of left ventricle.

Discussion

If we compare the numbers of papillary muscles with previous studies then, Gunnal SA *et al.*,⁷ observed many groups of papillary muscles instead of the usual two papillary muscles. They studied the left ventricles in 116 adult human hearts. The classical picture of papillary muscles – the presence of two papillary muscles in the left ventricle – was found in only four (3.44%) specimens, two groups of papillary muscles were seen in 50 (43.11%) specimens, three groups in 37 (31.90%) specimens, and four groups in 25 (21.55%) specimens.

Hosapatna M *et al.*,⁹ also observed presence of double anterior papillary muscle (APM) and posterior papillary muscle (PPM) in the left

ventricles in few cases out of 15 cadaveric hearts they studied.

According to Thounaojam OS *et al.*,¹⁰ in the anterior group of papillary muscles, single papillary muscle was most common in 13 (52%), 2 anterior papillary muscles were seen in 11 (44%) and 3 anterior papillary muscles were seen in 1 (4%). Single posterior papillary muscle was seen in 12 (48%), 2 posterior papillary muscles were seen in 8 (32%), 3 posterior papillary muscles in 2 (8%) and 4 posterior papillary muscles in 3 (12%) (Study was done in 25 fetal hearts.)

In the study of 105 normal hearts, Cheichi *et al.*¹¹ found that the antero-lateral papillary muscles were single in 87 (82.80%), double in 15 (14.30%) and triple in 3 (2.90%) and the postero-medial

papillary muscles were single in 31 (29.50%), double in 57 (54.30%), triple in 12 (11.40%) and even more than three in 5 (4.80%) hearts. Bhagya Shree *et al.*¹² studied the numbers of papillary muscles of the left ventricle in 50 adult human cadavers, they observed anterior (anterolateral) papillary muscle was composed of a single belly in 43 (86%) hearts and two bellies in 7 (14%) hearts and posterior (posteromedial) papillary muscle was composed of a single belly in 7 (14%) hearts, two bellies in 28 (56%) hearts, three bellies in 10 (20%) hearts, four bellies in 5 (10%) hearts. Ranganathan & Burch¹³ and Victor & Nayak¹⁴ also found the one or two anterior papillary muscle in majorities of the hearts but they occasionally found more than two anterior papillary muscles, which was not found in our study.

If we do comparison of all studies concerned with numbers of papillary muscles in anterior and posterior groups of papillary muscles then, some studies show that single papillary muscle in anterior group is most common including our study (Table 1) and double papillary muscles in posterior group are most common which was not seen commonly in our study.

Conclusion

We found many variations in the form of numbers of papillary muscles in anterior and posterior group of papillary muscles which was matched with some studies. This study may be helpful to anatomists and cardiothoracic surgeons. Many studies have shown that variations in the morphology of papillary muscles are of significance in surgical procedures.¹⁵⁻¹⁷

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A Morphometric Study of the Vertebral Body in Dry Human Typical Lumbar Vertebrae

Dhaval K Patil¹, Vaishali S Anturlikar²

Abstract

Background: The knowledge of various morphometric measurements of the vertebral body is essential for neurosurgeons and spinal surgeons for performing various operative procedures on the lumbar spine. The present study aims to create a morphometric database pertaining to the bodies of typical lumbar vertebrae. **Objective:** To measure the various dimensions of vertebral body in typical lumbar vertebrae. **Material and methods:** Two hundred dry human typical lumbar vertebrae of undetermined gender and age were selected for the study. The various parameters of vertebral body were measured. **Results:** The anteroposterior distance of the vertebral body in typical lumbar vertebrae ranged from 23.44 to 36.74 mm with a mean of 29.55 ± 2.93 mm. The transverse diameter of the vertebral body ranged from 33.54 to 54.06 mm with a mean of 42.37 ± 3.99 mm. The vertebral body width ranged from 29.26 to 48.98 mm with a mean of 37.23 ± 3.68 mm. The anterior height of the body ranged from 17.06 to 29.26 mm with a mean of 24.03 ± 2.14 mm. The posterior height of the body ranged from 17.84 to 31.42 mm with a mean of 25.28 ± 2.16 mm. **Conclusion:** The results provide a comprehensive database which will be helpful for designing of vertebral body instrumentations for Indian population.

Keywords: Vertebral body; Typical lumbar vertebra; Anterior height; Posterior height; Vertebral body width.

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Introduction

The lumbar vertebrae perform the function of supporting the weight of the upper body. Vertebral body is the key element in load bearing system of the spine. So, the vertebral bodies are subjected to significant loading stress which may be a contributing factor in low-back pain seen commonly in the Indian population. Besides this, the lumbar spine is involved in various other conditions such

as degenerative changes, infections, congenital defects, neoplastic metastases and accidents.

Anterior access to the lumbar vertebrae and disc spaces is increasingly used for lesion excision, corpectomy, vertebral body reconstruction with cages, realignment, and/or plating or screwing. Such approach provides direct access to most spine diseases and allows optimal neural decompression. Thus the possibility of adequate realignment and strong reconstruction/fixation is increased. In recent years, anterior lumbar interbody fusion for stabilization of spine has gained popularity. Expandable vertebral body replacement material is used to provide solid anterior column constructs along with restoration of height and sagittal alignment of the vertebrae. For a successful anterior approach and a suitable instrumental design, adequate morphometric knowledge about body of lumbar vertebrae is essential.¹

In a computerized medical robot-assisted surgery system, the morphometric data of the lumbar spine is needed to define the operational

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workspace for various surgical procedures on the spine.² The knowledge of measurements of the bodies of lumbar vertebrae is also helpful in diagnosing various pathological conditions and management of lower backache. It will also be helpful in various stabilization and correction procedures for deformities of spine. Hence, the present study measured the various dimensions of vertebral body.

Materials and Methods

The study was conducted on dry human typical lumbar vertebrae. The vertebrae were obtained from the bone collection of the department of Anatomy of a tertiary care hospital. Of the total collection of lumbar vertebrae in the department, 200 undamaged typical lumbar vertebrae were selected for the study. The vertebrae were of undetermined gender and age. Each vertebra was assigned a serial number. Anatomical measurements were taken on these specimens using a vernier caliper (0–150 mm with a precision

of 0.02 mm) (Fig. 1). The following parameters were recorded in a pro forma:

1. *Anteroposterior distance of the vertebral body:* It is the distance between anterior border and posterior border of the superior surface of vertebral body in midline.
2. *Transverse diameter of the vertebral body:* It is the maximum transverse diameter of the vertebral body at the superior surface.
3. *Vertebral body width:* It is the minimum transverse distance across the sides of vertebra in anterior view of the body.
4. *Anterior height of the body:* It is the vertical distance between superior and inferior surface of body in the midline anteriorly.
5. *Posterior height of the body:* It is the vertical distance between superior and inferior surface of body in the midline posteriorly.

The findings were recorded in tabulated form and statistical analysis was done using Microsoft Excel.

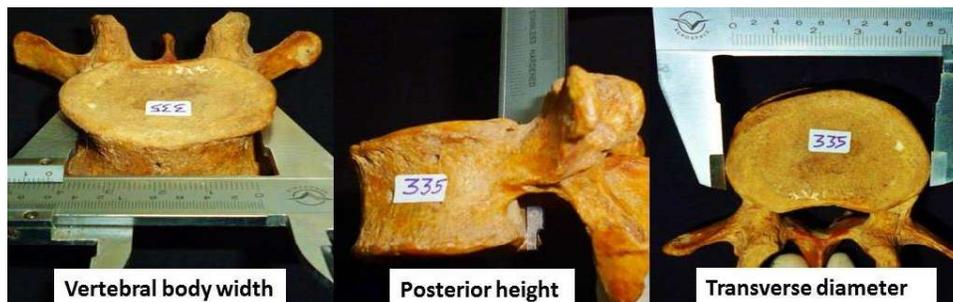


Fig. 1:

Results

1. The anteroposterior distance of the vertebral body in typical lumbar vertebrae ranged from 23.44 to 36.74 mm with a mean of 29.55 ± 2.93 mm.
2. The transverse diameter of the vertebral body in typical lumbar vertebrae ranged from 33.54 to 54.06 mm with a mean of 42.37 ± 3.99 mm.
3. The vertebral body width in typical lumbar vertebrae ranged from 29.26 to 48.98 mm with a mean of 37.23 ± 3.68 mm.
4. The anterior height of the body in typical lumbar vertebrae ranged from 17.06 to 29.26 mm with a mean of 24.03 ± 2.14 mm.
5. The posterior height of the body in typical

lumbar vertebrae ranged from 17.84 to 31.42 mm with a mean of 25.28 ± 2.16 mm.

Discussion

Several quantitative anatomical studies have been carried out for lumbar vertebrae in different countries. Many authors have studied the vertebrae using different methods such as direct specimen measurements, plain radiographs, CT scans and MRI scans. The studies which have focused on parameters pertaining to vertebral bodies include Issachar Gilad *et al.*,³ Alon Wolf *et al.*,² Tan *et al.*,⁴ Urrutia VE *et al.*,⁵ Gocmen-Mas N *et al.*,¹ Karabekir HS *et al.*,⁶ Alam MM *et al.*,⁷ Eisenstein S,⁸ Amonoo-Kuofi HS,⁹ Berry JL *et al.*,¹⁰ Nirvan AB *et al.*,¹¹ Gupta R *et al.*,¹² and Kanani SD *et al.*¹³ The following tables (Tables 1 to 4) present the comparison of means

of the various parameters obtained from previous studies with that of the present study.

Table 1 shows that the value reported by Tan *et al.*⁴ is similar to the value of the present study.

The mean anteroposterior distance of the vertebral body determined by the present study is lower than that of the other studies.

The mean transverse diameter of the vertebral

Table 1: Comparison of Mean Anteroposterior Distance of The Vertebral Body in Typical Lumbar Vertebrae with Other Studies

Study	Year	Country	Material for study	Mean (in mm)
Issachar Gilad <i>et al.</i> ³	1985	Israel	Radiographs	34.22
Alon Wolf <i>et al.</i> ²	2001	Israel	CT scans	30.68
Tan <i>et al.</i> ⁴	2004	Singapore	Dry bones	29.13
Urrutia VE <i>et al.</i> ⁵	2009	Mexico	CT scans	32.06
Gocmen-Mas N <i>et al.</i> ¹	2010	Turkey	MRI scans	35.52
Karabekir HS <i>et al.</i> ⁶	2011	Turkey	Dry bones	33.92 (L1 to L5)
Alam MM <i>et al.</i> ⁷	2014	Pakistan	CT scans	31.39
Present study		India	Dry bones	29.55

body in the present study is in consonance with that of Alon Wolf *et al.*,² Urrutia VE *et al.*,⁵ Tan *et al.*,⁴ Alam MM *et al.*,⁷ and Karabekir HS *et al.*,⁶

but is lower than that of Gocmen-Mas N *et al.*,¹ (Table 2).

Table 2: Comparison of Mean Transverse Diameter of The Vertebral Body in Typical Lumbar Vertebrae with Other Studies

Study	Year	Country	Material for study	Mean (in mm)
Alon Wolf <i>et al.</i> ²	2001	Israel	CT scans	41.93
Tan <i>et al.</i> ⁴	2004	Singapore	Dry bones	39.1
Urrutia VE <i>et al.</i> ⁵	2009	Mexico	CT scans	41.6
Gocmen-Mas N <i>et al.</i> ¹	2010	Turkey	MRI scans	52.68
Karabekir HS <i>et al.</i> ⁶	2011	Turkey	Dry bones	42.72
Alam MM <i>et al.</i> ⁷	2014	Pakistan	CT scans	43.16
Present study		India	Dry bones	42.37

The mean vertebral body width in the present study is comparable with that of Eisenstein S,⁸ Gupta R *et al.*¹² and Kanani SD *et al.*¹³ The mean is lesser than that found by Amonoo-Kuofi HS,⁹ Berry JL *et al.*,¹⁰ and

Nirvan AB *et al.*¹¹ (Table 3). Gupta R *et al.*,¹² mention that the vertebral body width ranged between 27.06 and 48.32 mm for typical lumbar vertebrae as compared to 29.26–48.98 mm in the present study.

Table 3: Comparison of mean vertebral body width in typical lumbar vertebrae with other studies

Study	Year	Country/ Race	Material for study	Mean (in mm)
Eisenstein S ⁸	1977	Caucasoid	Dry bones	38.88
		Negroid	Dry bones	39.06
Amonoo-Kuofi HS ⁹	1982	Nigeria	Radiographs	43.19
Berry JL <i>et al.</i> ¹⁰	1987	USA	Dry bones	41.85
Amonoo-Kuofi HS <i>et al.</i> ¹⁴	1990	Saudi Arabia	Radiographs	48.65
Nirvan AB <i>et al.</i> ¹¹	2005	India	Radiographs	42.45
Gupta R <i>et al.</i> ¹²	2011	India	Dry bones	38.9
Kanani SD <i>et al.</i> ¹³	2012	India	Dry bones	36.62
Present study		India	Dry bones	37.23

The mean anterior height of the body in the present study is greater than that found by Tan *et al.*⁴ but is slightly lower than other studies (Table 4). Table 4 shows that the mean posterior height of the body in the present study resembles with that

of Alon Wolf *et al.*² The value is slightly lower than that of Issachar Gilad *et al.*,³ Alan MM *et al.*⁷ and Karabekir HS *et al.*⁶ but is greater than the finding of Tan *et al.*⁴

Table 4: Comparison of mean anterior height and posterior height of the body in typical lumbar vertebrae with other studies

Study	Year	Country	Material for study	Mean Anterior Height (in mm)	Mean Posterior Height (in mm)
Issachar Gilad <i>et al.</i> ³	1985	Israel	Radiographs	26.98	27.28
Tan <i>et al.</i> ⁴	2004	Singapore	Dry bones	21	22.3
Gocmen-Mas N <i>et al.</i> ¹	2010	Turkey	MRI scans	25.1	-
Alon Wolf <i>et al.</i> ²	2001	Israel	CT scans	-	25.6
Karabekir HS <i>et al.</i> ⁶	2011	Turkey	Dry bones	26.52 (L1 to L5)	26.44 (L1 to L5)
Alam MM <i>et al.</i> ⁷	2014	Pakistan	CT scans	26.28	27.69
Present study		India	Dry bones	24.03	25.28

Conclusion

Thus, a comprehensive data set has been presented which provides quantitative anatomy of vertebral body of typical lumbar vertebrae. The differences in the results of the present study and those of the previous studies with respect to some of the parameters may be due to differences in race, ethnicity, environmental factors as well as methods used for the studies. These findings can be used for various comparative studies with respect to Indian population. The data will also help in designing various implants and selecting appropriate size for instruments for various procedures on the lumbar spine for Indian population. It also establishes the need for preoperative radiographic evaluation before planning a surgical intervention of the lumbar spine. In the future, the scope of the study can be further extended to study the vertebral column with respect to individual vertebral levels.

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Histopathological Changes in the Duodenum and Jejunum of Rabbits Exposed to High Nitrate Intake in Drinking Water

Manoj Kumar Sharma¹, Hemlata Sharma²

Abstract

Introduction: In India particularly in Rajasthan state, peoples drink water having high level of nitrates and concentration up to 500 mg of nitrate ion per liter is common. The ingested nitrate is converted to nitrite in the digestive system and absorb in blood causing methemoglobinemia. The peak of methemoglobin is observed at 45–95 mg/Liter of nitrate concentration of water. **Aim of study:** To find out the correlation between drinking water nitrate concentration and histopathological changes in duodenum and jejunum of rabbits of different groups. **Materials & Methods:** An experimental study was conducted in 10 rabbits according to guideline of ICMR, New Delhi between three and a half months to four months of age having weight ranging from 1.310 kg to 10720 kg. Five groups A, B, C, and D & E were formed with two rabbits in each group. The control group A was given water orally having 06 mg/liter. Groups B to E (experimental groups) were administered water orally having a concentration of 100 mg/Liter, 200 mg/Liter, 400 mg/Liter & 500 mg/Liter of nitrate respectively for 120 days. Then all rabbits were anaesthetized and sacrificed according to the guidelines of the ICMR and duodenum and jejunum were removed and processed for paraffin sections. Hemotoxyllin and eosin staining was done for microscopic observations. **Results:** The results showed mononuclear infiltration and ulceration of epithelium in mucosa of duodenum and jejunum which started in Group B. The histopathological changes appeared in sub-mucosa, muscularismucosa, muscularisexterna and serosa, started from Group C as exfoliation, crowding and stratification of epithelium. The changes were more pronounced in duodenum and jejunum of group D & E in the form of congestion of blood vessels in sub mucosa and mild infiltration of lymphocytes in muscularisexterna and abnormal villi.

Keywords: Duodenum; Jejunum; Small intestine; Nitrate; Nitrite; Histopathology; Rabbits.

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Introduction

The majority of population of India is exposed to nitrate through ground water and dietary sources.¹ Excessive nitrate concentration in drinking water is reported to have caused methemoglobinemia in infants up to 6 months of age.^{2,3} Maximum

permissible limit for nitrate ion in drinking water has been set at 50 mg/Liter by WHO and 45 mg/Liter by Bureau of Indian Standard (IS-10500).⁴⁻⁶

In few developing countries high nitrate concentration at times up to 500 mg/liter is not uncommon.⁷ In our body, the nitrates are reduced to nitrite and leads to methemoglobinemia which occurs through microbial action either in environment or in the body so, the health risk from exposure to nitrate are therefore related not only to their concentration in drinking water and food condition conducive but also to their reduction to nitrites.⁷ Few studies explained that reduction of nitrate to nitrite starts even in the oral cavity.^{8,9}

The present animal study on rabbits fed on nitrate rich water reports lymphocytic infiltration, atrophy of mucosa, interstitial round cell infiltration and fibrosis at certain areas.

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In some Indian villages, people have been consuming water containing high nitrate concentration at time up to 500 mg/liter is not uncommon. As the above reported data, it was planned to study the toxicological effects of nitrate exposure in an appropriate animal under laboratory conditions.

Aim of study

As the above reported data, it was planned to study the toxicological effects of high nitrate due to exposure in drinking water in an appropriate animal study under laboratory conditions.

Materials and Methods

The study was conducted in the Anatomy department, S.M.S Medical College and attached group of hospitals, Jaipur, Rajasthan on five groups of 2 rabbits each. The rabbits were used for the study because their stomach pH is similar to infant (pH = 3.0–5.0).^{9,10} The age of rabbits was three and a half to four months and weight varied from 1.310 kg to 1.720 kg. These groups were identified as A, B, C, D & E. The water containing 45, 100, 200, 400 and 500 mg/Liter nitrate (in the form of NaNO₃) were provided ad libitum and food soaked in the same water were also given to group A to E respectively. The group consuming 45 mg/Liter named as a control group. The observations were made during the experimental period of 120 days for the changes in physical activity of the animals on a predesigned pro forma after every 15 days. After 120 days, all animals were sacrificed according to the guidelines of ICMR and dissected. The duodenum and jejunum

were removed and biopsy was taken from the organ. These tissues were fixed in 10% formalin solution and stored for histopathological examination.

Results

Histopathological Changes in Duodenum: The mucosa, sub-mucosa, muscularisexterna and serosa was absolutely normal in Group A rabbits but changes starts in rabbits of Group B. There was ulceration of mucosa and moderate inflammation in duodenum. Some slides showed abnormal villi also. Sub serosa, muscularisexterna and serosa showed normal histology in Group C. In Group D, the duodenum showed moderate inflammatory inflammation and ulceration in mucosa and mild inflammatory inflammation in muscularis mucosa. The serosa was normal. In GI tract of Group E, the duodenum showed conversion of epithelium into low columnar cells. The mucosa and sub-mucosa showed dense collection of mononuclear cells. alceration of epithelium and abnormal villi were observed in mucosa and congested blood vessels was observed in serosa (Fig. 1, 3, 5, 7) (Table 1).

Histopathological Changes in Jejunum: The mucosa, sub-mucosa, muscularisexterna and serosa was absolutely normal in Group A rabbits. The changes starts in rabbits of Group B in form of ulceration of epithelium and mild lymphocytic infiltration and plasma cells infiltration in mucosa. In GI tract of Group C, the jejunum showed ulceration, exfoliation, crowding and stratification of epithelium. There was moderate infiltration of lymphocytes, plasma cells, eosinophils and

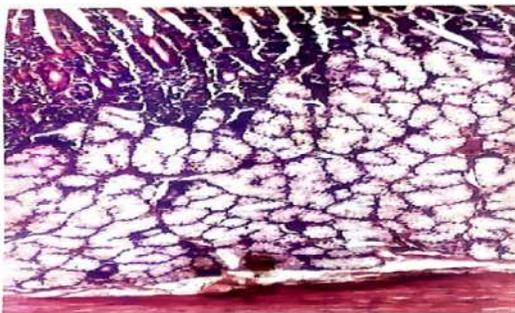


Fig. 1: Microphotograph of duodenum showing mild lymphocytic infiltration in lamina propria. (10X), Group B

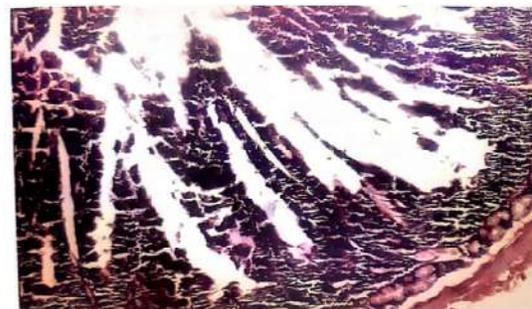


Fig. 2: Microphotograph of jejunum showing epithelial shedding. (10X), Group B

neutrophils in mucosa. The submucosa, muscularis mucosa and serosa were observed normal. The Group D rabbits showed ulceration of epithelium and moderately inflammatory inflammation in

mucosa and severe infiltration of lymphocytes and plasma cells in submucosa. The congestion of blood vessels in mucosa and serosa were observed. The muscularisexterna was normal. The maximum

pathological changes were observed in Group E, in which jejunum showed marked inflammatory inflammation in mucosa and submucosa. There was marked ulceration of epithelium in mucosa.

The severe congestion of blood vessels in mucosa and serosa were observed. The muscularisexterna did not showed any significant change (Figs. 2, 4, 6, 8, 9) (Table 2).

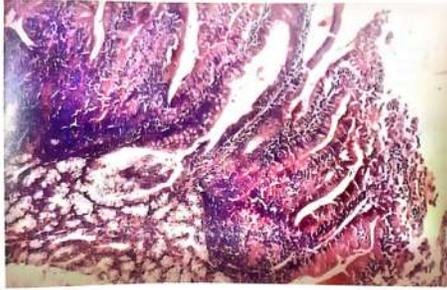


Fig. 3: Microphotograph of duodenum showing marked epithelial ulceration and moderate mononuclear infiltration in lamina propria. (10X), Group C

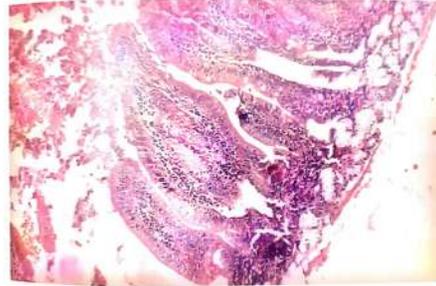


Fig. 4: Microphotograph of jejunum showing marked epithelial ulceration and moderate mononuclear infiltration in lamina propria. (10X), Group C

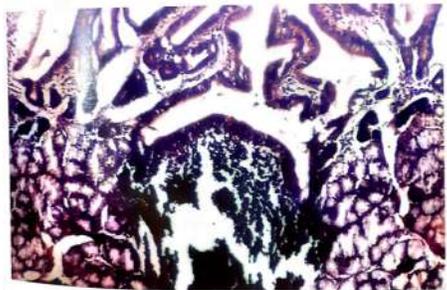


Fig. 5: Microphotograph of duodenum showing lymphoid aggregation in lamina propria. (10X), Group D

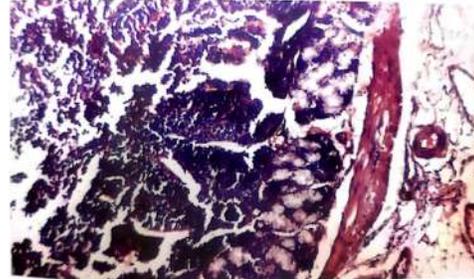


Fig. 6: Microphotograph of jejunum showing marked ulceration of epithelium and mononuclear infiltration in lamina propria. (10X), Group D

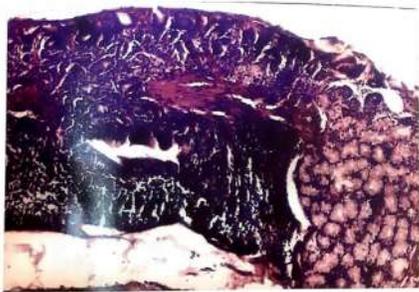


Fig. 7: Microphotograph of duodenum showing lymphoid aggregation in sub mucosa and shortening of villi. (10X), Group E

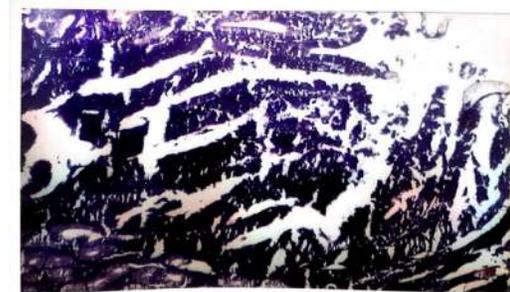


Fig. 8: Microphotograph of jejunum showing epithelial ulceration and dilated congested blood vessels in the lamina propria. (10X), Group E

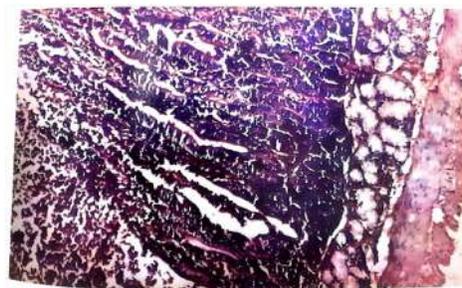


Fig. 9: Microphotograph of jejunum showing marked epithelial ulceration. (10X), Group E

Table 1: Microscopic Changes in Duodenum with Different Concentration of Nitrate

	Group A	Group B	Group C	Group D	Group E
Mucosa	-	0+	0+	0++×	0+++×
Submucosa	-	-	-	+++	+++
Muscularis Externa	-	-	-	-	-
Serosa	-	-	-	×	×
- Normal histology		+ Mild inflammation		++ Moderate inflammation	
+++ Severe inflammation		0 Ulceration of epithelium		×	×
				×	×

Table 2: Microscopic Changes in Jejunum with Different Concentration of Nitrate

	Group A	Group B	Group C	Group D	Group E
Mucosa	-	0+	0++*	0++	0+++*
Submucosa	-	-	-	++	+++
Muscularis externa	-	-	-	+	-
Serosa	-	-	-	-	×
- Normal histology		+ Mild inflammation		++ Moderate inflammation	
+++ Severe inflammation		0 Ulceration of epithelium		* abnormal villi	

Discussion and Conclusion

The duodenum of rabbits in Group A did not any pathological changes. The histopathological changes were observed in mucosa of Group B in the form of ulceration of epithelium and mild infiltration of lymphocytes with plasma cells. The changes were more pronounced as the nitrate concentration increased in drinking water. In Group E, the mucosa showed ulceration of epithelium, abnormal villi, severe infiltration of lymphocytes and plasma cells in submucosa.

The histopathological changes started in Jejunum in Group B in form of ulceration of mucosa and mild inflammation. The increased nitrate concentration causes severe changes consisting of congestion of blood vessels, severe inflammation and ulceration of epithelium as observed in Group E. severe inflammation of sub mucosa was seen in Group D & E only which also showed involvement of the serosa in the form of congestion of blood vessels.

Farrant M *et al.* (1945) studied the two cases of methaemoglobin in newborn caused by nitrates in well water. The microscopic data of intestinal wall showed confluent ulceration with marked thickening.¹⁰

No more references regarding the study of histopathological changes in duodenum and jejunum associated with ingestion of high nitrate concentration in the drinking water could be found inspite of best efforts made to search the literature.

The results of present study proved strong interdependence between high nitrate concentration and histopathological changes in duodenum

and jejunum. The damage in tissue was more pronounced as nitrate concentration increased.^{11,12} The nitrate problem is not taken up seriously in our country till date. It is expected that the findings will draw attention about the seriousness of problem and people will get safe water for drinking.

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Perception of Students for Teaching, Learning and Assessment Technique of Gross Anatomy

Savita Kadam¹, Minal Kadam², Smita Shinde³, Gautum Shroff⁴

Abstract

Objectives: An opinion regarding different teaching, learning and assessment techniques of gross anatomy taken from 147 first MBBS students at MGM Medical College and Hospital, Aurangabad, Maharashtra with the help of specially designed questionnaire. **Materials and Methods:** Cross sectional study was conducted in the Department of Anatomy MGM Medical College, Aurangabad, Maharashtra with the help of predesigned questionnaire to the interest of 1st MBBS students batch 2018-19 in different teaching, learning and assessment techniques of gross anatomy. **Results:** Out of total, 50.34% of them were male and all were between the age group of 18-22 years. Most of the students were from State Board (63.95%). 37.50% students preferred small group teaching. 54.91% preferred dissection hall teaching for practical. Textbook is preferred as a best source of study material by majority of students (45%). Most of the students consider LCD as the best teaching methodology. 61.11% students believe that multimedia teaching relies on scientific contents is not boring and does not cause lack of attention. According to majority of students (61.64%), multimedia teaching is affected by teaching method, skill of faculty and ability to imagine relationship. 51.68% students consider part completion test as the best assessment technique to measure knowledge in theory. **Conclusion:** Anatomy forms backbone of medical education for 1st MBBS students. This study assesses effectiveness of modern method versus old chalkboard method of teaching gross anatomy. Such studies give us an idea of our area of deficiencies and strengths of teaching methods which help in bringing corrective measures in future. Students welcomed PBL, horizontal and vertical integration and e-learning. Students preferred LCD (Lecture cum demonstration) over lecture with chalk and board. Surprisingly students preferred text book over teacher's notes. Students are interested in multimedia teaching. Students favoured part completion test over weekly tests.

Keywords: Teaching method; Gross anatomy; Students perception; Learning aids; Assessment techniques.

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Introduction

The medical education has been undergoing dramatic changes worldwide. The medical and health care in India are facing serious challenges in content and competencies. Newer interactive teaching methodologies have paved their way into medical teaching. Nowadays, objective of teaching

is not only to give information to students but also to make interactive sessions for early development of skills in medical students. There is need in this hour to include more interactive and effective teaching modalities in medical curriculum to meet the challenges ahead for future doctors. We should improve the quality of the medical education rather than quantity. Anatomy is supposed to be a difficult preclinical subject hence it has got maximum teaching hours in 1st MBBS. Teaching and learning anatomy in preclinical discipline is one of the most important challenges for both teachers and students.¹ Traditionally teaching the students of gross anatomy has been done through cadaver dissections and didactic lectures.² Many previous studies have shown that students prefer practical teaching of anatomy at dissection hall. Anatomy is an essential foundation for clinical

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sciences. Main purpose of medical education is to create medical students with knowledge, skill and attitudes expected from a basic doctor—either in private practice or in government service. Students acquire fundamental skills and learning techniques that will serve them during their lifelong medical training.³ “The use of cadavers has been the chief pillar for learning anatomy.”⁴ Recent technologies like three-dimensional audio visuals, digital radiological imaging, and web-based study materials, use of models; plasticines; etc. have been introduced to make Anatomy more interesting and easier among the students as well as teachers.² In the modern concept of medical education, the role of the faculty member is to facilitate the learning process. It is important to use multiple techniques in order to reach as many different types of learners as possible.⁵ Student feedback is useful basis for modifying and improving medical education. Keeping this idea in mind recent study was conducted in MGM medical college Aurangabad to elicit 1st year student’s perception regarding teaching aids, learning and assessment techniques appropriate to gross anatomy

Aims and Objectives

1. To evaluate the feedback on teaching and

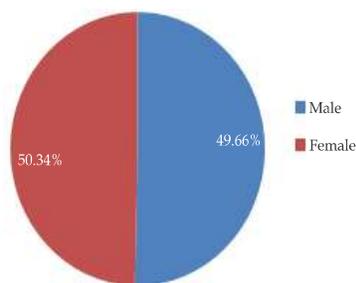


Fig. 1:

2. To detect lacunae in our teaching and assessment technique and improve it
3. To identify the most favorite teaching and learning method of students

Materials and Methods

Study Type and Design

Cross sectional study was done on 147 First year 2nd semester students after completion of entire syllabus of gross Anatomy in the department of anatomy at MGM Medical College Aurangabad by using specially designed questionnaire related to teaching and learning methods and assessment techniques of gross anatomy. The students were briefed about the questionnaire and asked to respond freely and fearlessly. Anonymity and confidentiality was ensured to all students. The purpose of study was explained to students. They were asked not to put their names on questionnaire. They were also asked to go through the questionnaire thoroughly and to tick whichever option they choose. They were

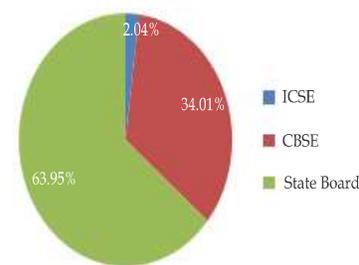


Fig. 2:

Table 1: Best Teaching Method for Theory Class

Best teaching method for theory class	Number in favor	Percentage
Lecture	42	25.00
PBL	38	22.62
Small group	63	37.50
Interactive media	25	14.88

37.50% students preferred small group teaching (Table 1).

Table 2: Preferred Teaching for Practical

Preferred teaching for practical	Number in favor	Percentage
Dissection	95	54.91
Processection	1	0.58
Educational videos	39	22.54
Anatomical models	38	21.97

54.91% preferred dissection hall teaching for practical (Table 2).

Table 3: Best Source of Study Material

Best source of study material	Number in favor	Percentage
Classroom study	64	35.56
Text book	81	45.00
Reference books	12	6.67
E-resources	23	12.78

Text Book is preferred as a best source of study material by majority of students (45%) (Table 3).

Table 4: Best Teaching Methodology

Best teaching methodology	Number in favor	Percentage
Dissection hall teaching and chalk board	55	31.43
Chalkboard teaching and models	36	20.57
Only multimedia	8	4.57
LCD	76	43.43

Most of the students consider LCD as the best teaching methodology (Table 4).

Table 5: Multimedia's Teaching

Multimedia's teaching	Number in favor	Percentage
Relies on scientific contents	21	14.58
Does not cause lack of attention	19	13.19
Not Boring	16	11.11
All of the above	88	61.11

61.11% students believe that multimedia teaching relies on scientific contents, is not boring and does not cause lack of attention (Table 5).

Table 6: Factors Affecting Multimedia Teaching

Factors affecting multimedia teaching	Number in favor	Percentage
Teaching methods	20	13.70
Skill of faculty	17	11.64
Ability to imagine relationship	19	13.01
All of the above	90	61.64

According to majority of students (61.64%), multimedia teaching is affected by teaching method, skill of faculty and ability to imagine relationship (Table 6).

Table 7: Best Assessment Technique

Best assessment technique	Number in favor	Percentage
A weekly test	45	30.20
Part completion test	77	51.68
Six monthly test	14	9.40
A yearly test	13	8.72

51.68% students consider part completion test as the best assessment technique to measure knowledge in theory (Table 7).

also informed that they can choose more than one option. The questionnaires were collected back. The answers given by student were analyzed.

Results

Cross-sectional study was undertaken among the 147 First year MBBS students of MGM Medical College Aurangabad Maharashtra in the department of Anatomy after completion of entire syllabus of gross anatomy to access their perception regarding teaching, learning and method of assessment with

the help of prestructured questionnaire. Out of total, 50.34% of them were male and all were between the age group of 18–22 years. Most of the students were from State Board (63.95%) (Figs. 1 and 2).

Discussion

Medical education is a continuous process, teaching from undergraduate study of Anatomy to a call with a specialist when facing a difficult case as a practitioner. Learning in medicine is a lifelong process and needs deliberate practice

of desired educational outcomes.⁶ Study carried out by J. Thirunavukkarasu, shows that to gain knowledge, interactive lectures; i.e., tutorial and group discussions were more useful.⁷ To achieve this goal of undergraduate education program for medical education, teaching and learning methods should be learner oriented with focus on application of knowledge rather than mere acquisition of knowledge.⁸ In our study 50.34% were male and 49.66% were female. Mean age of students of present study is about 19.20 ± 0.64 . As students entering medical colleges are from different boards their ideologies are different due to their varying nurturing. In our study 63.95% students are from state board, 34.01% from CBSE and only 2.04% from ICSE. In our study 37.50% students preferred small group teaching method which is similar to study done by S.K Nagar *et al.* where 79.71% students preferred small group teaching as an important guide for learning gross anatomy. In our study 54.91% students felt that dissection hall teaching is best method for practical followed by educational videos (22.54%), Anatomical models (21.97%) and Procection (0.58%). In present study 45% students preferred text book as best source of study followed by teacher's notes (35.56%), e-resources (12.78%) and reference books (6.67%), which is in contrast with the study done by Rashmi Jaiswal and *et al.* where 48.83% students preferred teacher's notes followed by textbooks (36.43%). In our study best teaching methodology is LCD (Lecture cum demonstration); i.e., 43.43% followed by dissection hall teaching and chalk board (31.43%), chalk board teaching and models (20.27%) and only multimedia (4.57%), which is also in contradiction with study done by Rashmi Jaiswal and *et al.* where 52.71% liked dissection hall and chalkboard. In the study of Rashmi Jaiswal and *et al.* 48.06% students agreed that multimedia teaching methods depends on skill of teacher and ability to imagine relationship of various organs (11.50%) whereas in our study according to 61.64% students multimedia teaching method is multifactorial and depends on many factors such as skill of teacher, ability to imagine relationship of various organs and teaching methods such as videos, PPTs; etc. In the study of S. K. Nagar, majority of students were in favor of weekly test (70.80%) and part completion examination (63.50%) as a best technique of assessment to judge the theory knowledge of gross anatomy, whereas in our study 51.68% students favor part completion test and 30.20% student favor weekly test. In our study, 61.11% students want multimedia teaching as it is not boring, it does not cause lack of attention and relies on scientific contents.

Conclusion

Anatomy forms backbone of medical education for 1st MBBS students. This study assesses effectiveness of modern method versus old chalkboard method of teaching gross anatomy. Such studies give us an idea of our area of deficiencies and strengths of teaching methods which help in bringing corrective measures in future. Students welcomed PBL, horizontal and vertical integration and e-learning. Students preferred LCD (Lecture cum demonstration) over lecture with chalk and board. Surprisingly students preferred text book over teacher's notes. Students are interested in multimedia teaching. Students favoured part completion test over weekly tests.

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A Morphometric Study of Normal Parietal and Coronal Suture's Width in Indian Infant Population by CT Imaging

Wasim Hiroli¹, Saurabh Prakash Kulkarni², Arun Kasote³

Abstract

Background: The skull of newborn normally consists of seven bones: the paired frontal, temporal, and parietal bones, and the single occipital bone, and six sutures including the paired coronal and lambdoid sutures, and the single sagittal and metopic sutures. The anatomical knowledge of the pediatric skull is a challenging task, and the stages of its development are not easily recalled by radiologists. **Materials and Methods:** The sagittal suture and bilateral coronal sutures were evaluated for 483 patients, ages 1 day to 395 days collected retrospectively from electronic medical records. Histograms as well as normality and boxplots were used to view the distribution of the data. **Results:** The average proximal suture widths for the sagittal and coronal sutures at zero months of age were 4.9 ± 0.13 and 2.45 ± 0.13 mm, respectively. From zero to 1 month of age, these sutures narrowed significantly to 2.3 ± 0.15 and 1.3 ± 0.13 mm, respectively. From 1 to 12 months of age, sutures narrowed gradually. The proximal coronal suture widths showed a significant reduction from 1 month to 12 months (1.3 ± 0.13 to 0.85 ± 0.12 mm). **Conclusions:** This study provides normal reference values for suture widths established by CT scan among a sample of Indian infant population and it may be used to assess the infant calvaria for suture diastasis.

Keywords: Newborn skull; Parietal suture; Coronal suture's width; CT scan.

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Introduction

The skull of newborn normally consists of seven bones: the paired frontal, temporal, and parietal bones, and the single occipital bone, and six sutures including the paired coronal and lambdoid sutures, and the single sagittal and metopic sutures.^{1,2} The anatomical knowledge of the pediatric skull is a challenging task, and the stages of its development are not easily recalled by radiologists. This comes

from the variable nature and changing appearances of sutures over the normal developmental period.³ The large sutures are seen in all infants less than 12 months of age and toddlers (1-4 years) and persist into adulthood.⁴ The sutures are fibrous type of joint that occurs only in the skull. The metopic suture, typically closes around 9-24 months; the sagittal suture, closes at around 22 years of age; the coronal suture closes at around 24 years; and the lambdoid suture close at around 26 years.^{5,6}

In United States of America there has seen a recent rise in the number of emergency department visits from 352.8 to 390.5 per 1000 persons over the time span of 1997-2007.⁷ This trend is also reflected in the pediatric population.⁸ Pediatric head trauma is a common presentation for emergency department and acute care clinic visits in developed countries but in developing countries it may varies from congenital cause to infections.

Henderson and Sherman were the first to assess

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neonate sutures. They evaluated 100 neonate infants by radiography, demonstrating a large variation in the coronal and sagittal suture widths.⁹ To assess sutural diastasis, Erasmie *et al.* recorded numerical data from CT imaging; however, it is insufficient in providing an assessment of the intracranial anatomy or pathology.¹⁰ With advancement in sonography technology, sutural appearance and intracranial distances can be assessed to determine normality.⁹ In the acute setting, however, sonography is not the preferred method of assessing the pediatric head due to variability between ultrasonographers, ultrasonographer availability,¹¹ and limited overall assessment of intracranial contents. In acute setting, a close evaluation of morphologic features of the suture is performed to assess for diastasis,¹² early closure¹³ and fracture.

There is very little literature describing normal suture width among infants in Indian population and lack of normal standard values on CT, hence this study was taken to assist radiologist in diagnosing cranial suture abnormalities.

Materials and Methods

A review of CT imaging reports on the PACs (Picture Archiving and Communication System) identified patients with a normal CT of the head was performed; the study included head CTs

conducted among patients 1 year of age or younger during September 2017 to May 2019 in government medical college, Jalgaon. The preterm infants and infants who had undergone cranial surgery were excluded from the study.

The width of each of the cranial sutures (sagittal, coronal) was measured. All measurements were made using the integrated calipers on the workstation software (GE Medical Systems), and had been performed with 2-slice CT scanner; with slice thickness of 5 mm and window width/level of 3000/550 HU. The study sample included 483 patients between 1 and 395 days of age (mean, 96 days). The CT data available included 966 sagittal suture evaluations and 1932 coronal suture evaluations.

Among the selected patients, 251 were male and 232 female, with a disproportionate representation of the neonate cohorts as reflected by the low mean months of age (Table 1) but with similar histories across the age groups (Table 2). Age, in days, was abstracted from the radiologic information system. The age in weeks was calculated by dividing the provided days of life by 7, and the month of life was determined based on a 30-day average month, with the assigned month representing the last complete month of life. Patients were subsequently assigned into the following 6 age groups for analysis: 0, 1, 2, 3, 6, and 12 months.

Table 1: Patient demographics

Sr. No	Age group	Male	Female	Total
1.	0	64	72	136
2.	1	32	31	63
3.	2	30	49	79
4.	3	50	21	71
5.	6	45	22	67
6.	12	25	7	32

Table 2: Indication for CT Imaging Study

Sr. No	Indications	0	1	2	3	6	12
1.	Infections	52	18	28	24	21	8
2.	Congenital anomalies	26	12	18	17	16	7
3.	Seizure	22	14	14	11	9	6
4.	ICSOL	11	6	8	7	8	6
5.	Trauma	9	6	5	6	7	2
6.	Others	16	7	6	6	6	3
	Total	136	63	79	71	67	32

CT Imaging Analysis

The sagittal suture and bilateral coronal sutures were evaluated on axial imaging by using a measurement selection point similar to Erasmie

and Ringertz and electronic calipers measuring distances along the inner margin of the suture. The proximal sagittal, right and left coronal suture width measurements were made in relation to the

anterior fontanelle. The distal sagittal and right and left coronal suture width measurements were made in relation to lamboid and sphenosquamous

fontanelle respectively which was confirmed on cross-referenced lateral scout images, and reviewed by 2 senior radiologists.

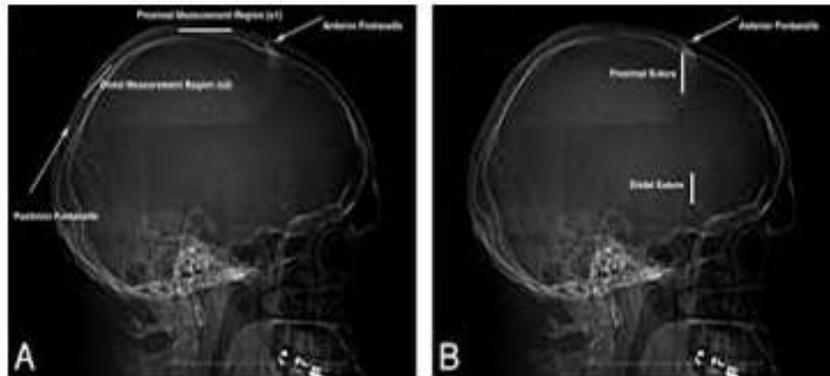


Fig 1: Suture evaluation. (A), Lateral image from CT scan of a young child demonstrating the location of proximal (s1) and distal (s2) sagittal suture measurements and were obtained at a minimum distance of 5 mm from the associated fontanelle. (B), Lateral image from CT scan of a young child demonstrating the location of proximal and distal measurements of coronal suture and were obtained at a minimum distance of 5 mm from the anterior fontanelle and the sphenosquamous suture

Results

Assessment of Sagittal Suture Width

The mean proximal sagittal suture width at 0 months of age was 4.93 ± 0.13 mm (Fig. 2; Table 3). In comparison to neonates, the mean proximal suture width of 1-month-olds was approximately half (2.38 ± 0.15 mm; $p < 0.001$). In comparison with 1-month-olds, infants 6 months of age had significantly narrower mean suture widths ($p < 0.001$) and likewise for infants 12 months of age compared with 1-month-olds ($p < 0.001$; Fig. 2 and Table 3). Other month-by-month comparison between 2, 3, 6, and 12 months did not reach

significance.

The mean distal sagittal suture width at 0 months of age was 4.67 ± 0.31 mm (Fig. 2). In comparison to neonates, the mean distal sagittal suture width of 1-month-olds was approximately 45% narrower (2.46 ± 0.17 mm; $p < 0.001$). Compared with 1-month-olds, the mean suture width of the 3-month olds was significantly narrower as was that of 6-month-olds and 12-month-olds ($p < 0.0001$). The decrease in suture width did not continue to reach statistical significance for other month-by-month comparison with the exception of 2 months and 12 months ($p < 0.028$; Fig. 2 and Table 3).

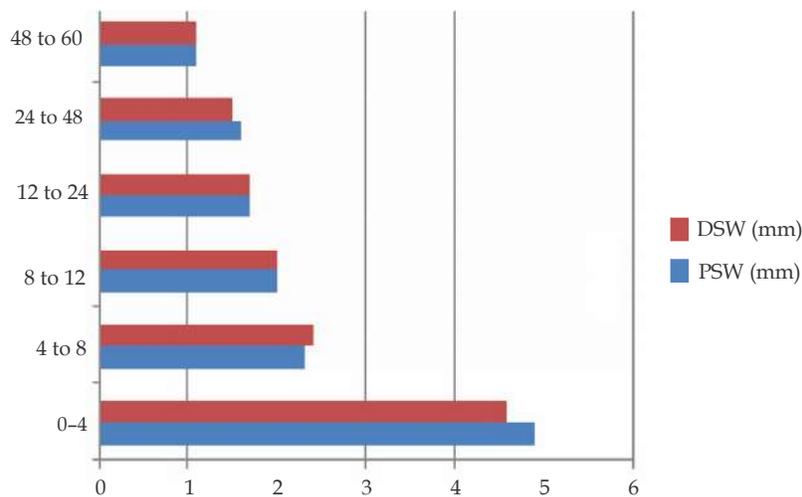


Fig 2: Sagittal suture width. Age variation of the proximal and distal sagittal suture width over a 1-year period. Data are represented as means \pm SE (n = 27-156).

Table 3: Sagittal suture width measurements

Age group (wk)	PSW (mm)	DSW (mm)
0 to 4	4.9	4.6
4 to 8	2.3	2.4
8 to 12	2	2
12 to 24	1.7	1.7
24 to 48	1.6	1.5
48 to 60	1.1	1.1

Assessment of Coronal Suture Width

The right and left coronal sutures closed at the same rate as reflected by mean widths that were statistically indistinguishable from each other at all time points measured (Table 4 and Fig. 3). In contrast, there was significant difference between mean proximal coronal suture width at 0 months of age and 1 month of age, 2.47 ± 0.13 and 1.37 ± 0.13 mm, respectively ($p < 0.001$). Unlike the sagittal suture, there was no significant reduction in the mean proximal coronal suture width between

1 and 12 months of age (1.37 ± 0.13 versus 0.84 ± 0.12 mm; Fig. 3). The mean distal coronal suture width at zero months of age was 1.52 ± 0.02 mm (Fig. 4). By the first month of age, the mean distal suture width had decreased significantly to 1.18 ± 0.09 mm ($p < 0.001$). There was no statistically significant reduction in the suture width between 1 and 3 months of age. The large number of coronal CT evaluations supported findings of statistical significance by 12 months of age versus 1, 2, 3, and 6 months ($p < 0.001$, 0.002, 0.001, and 0.031, respectively).

Table 4: Coronal Suture Width Measurements

Age group (wk)	RPC (mm)	RDC (mm)	LPC (mm)	LDC (mm)
0	2.5	1.5	2.4	1.5
1	1.3	1.1	1.3	1.1
2	1.2	0.9	1.2	0.9
3	1.1	1.0	1.1	1.0
6	1.1	0.8	1.0	0.8
12	0.8	0.5	0.9	0.5

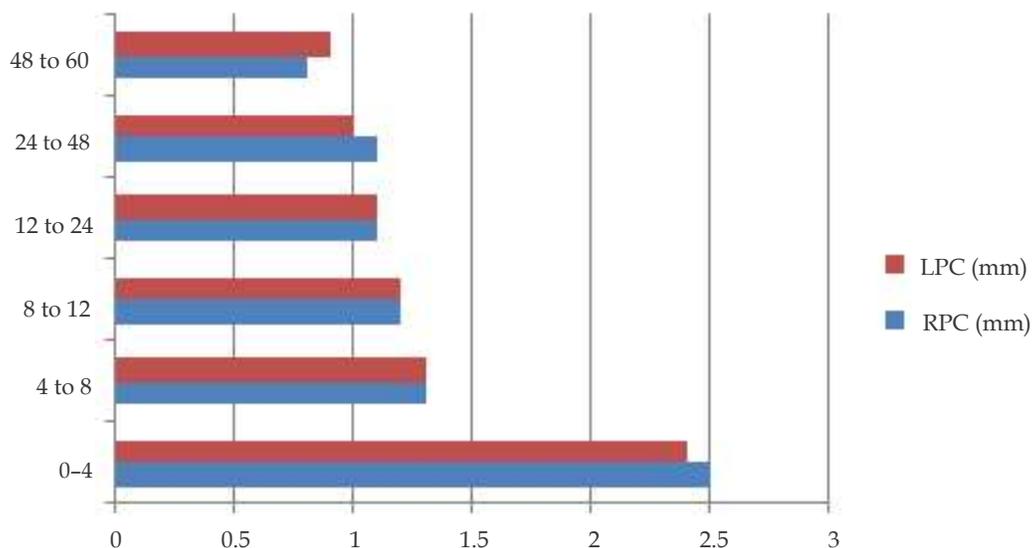


Fig 3: Comparison of the right and left proximal coronal suture widths over a 1-year-period. At each time point, there was no difference between the right and left coronal suture. Data are represented as means \pm SE (n = 27-156).

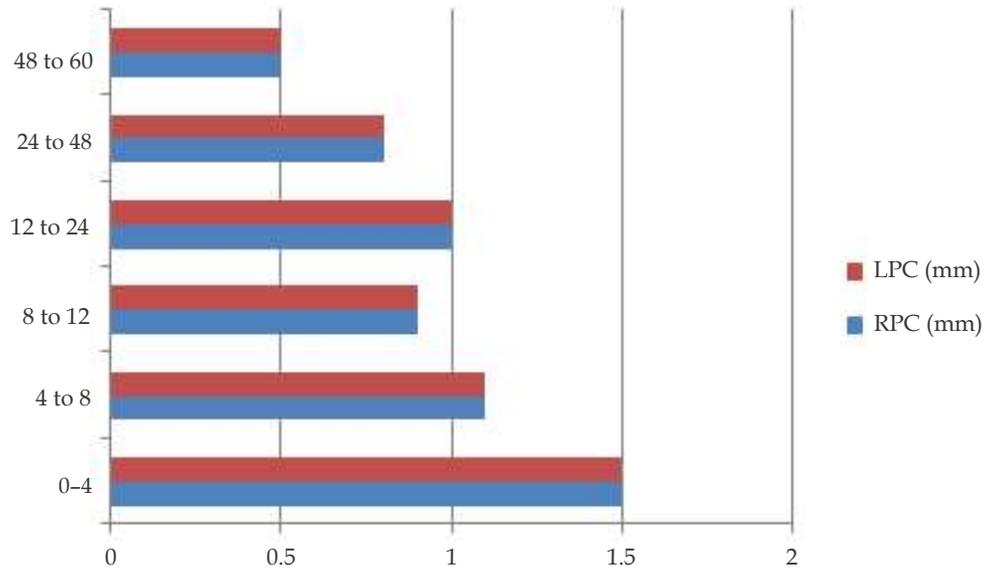


Fig 4: Comparison of the right and distal (B) coronal suture widths over a 1-year-period. At each time point, there was no difference between the right and left coronal suture. Data are represented as means \pm SE (n = 27-156).

Discussion

Nowdays, the matter of using emergency departments for paediatric evaluation has been raised leading to increasing number of neonates and infants undergo CT imaging of head for various reasons. Therefore essential information about normal suture width in infants can be helpful in the assessment of CT scan prevent the concern of sutural fracture.

This study expands on the evaluation of suture initially discussed by Mitchell. Our data portray a CT table of sagittal and coronal suture width throughout first year of life. Infections and congenital anomalies are the main reason for undergoing CT imaging of head in the infants in our study.

Mitchell *et al.*⁹ studied and reported the appearance of coronal and sagittal suture in normal infants on CT scan. They calculated the width of cranial sutures on CT scan in 483 patients between 1 and 395 days of age. They found that the proximal and distal suture widths for the sagittal suture was 5, 2.4, 1.1 mm and 4.6, 2.6, 1.1 mm at zero, first, and 12 months of age, respectively. They reported a significant difference between mean proximal sagittal suture width at 0 months with 1 month of age, and 1 month with 12 months of age. Similar to the mentioned study, the mean proximal and distal sagittal suture widths in our study was 2.3 for infants <2 months of age, but at 12 months of age it was 1.1 mm. Also, similar to Mitchell *et al.*⁷ results,

we found a significant difference between mean sagittal suture width at <2 months and 12 months of age. The right and left proximal coronal suture widths in Mitchell *et al.*, study was 2.5, 1.3, 0.8 mm and 1.5, 1.1, 0.5 mm at zero, first, and 12 months of age, respectively. The mean right proximal and left coronal suture width in our study was 1.3 and 0.8 at <2 and 12 months of age, which was similar to the mentioned study for 1 month of age and was higher for 12 months of age. They reported a significant difference between mean suture width at 0 months and 1 months of age, but they did not find a significant reduction in the mean suture width between 1 and 12 months of age. The right and left distal coronal suture widths in Mitchell *et al.*, study was 2.4, 1.3, 0.8 mm and 1.5, 1.1, 0.5mm at zero, first, and 12 months of age, respectively. The mean left proximal and left coronal suture width in our study was 1.1 and 0.5 at <2 and 12 months of age, which was similar to the mentioned study for 1 months of age and was higher for 12 months of age. They reported a significant difference between mean suture width at 0 month and 1 month of age, but they did not find a significant reduction in the mean suture width between 1 and 12 months of age. Our findings as well as Mitchell *et al.* study provided appropriate information about coronal and sagittal suture widths in infants lower than 12 months of age based on CT scans for assessments of infants' skull.⁹

Riahinezhad M *et al.*¹⁴ studied the evaluation of sutures widths by CT scans in infants throughout

the first year of life. They calculated the average width of the coronal suture was 2.37 mm at age of <2 months, narrowing significantly to 1.67 mm by 12 months of age. The average width of the sagittal suture was 2.76 mm at age <2 month, narrowing significantly to 1.63 mm at 12 months. Also, the coronal suture in male infants was significantly larger than female infants but other sutures are similar in size between males and females. In subgroup analyzes, a significant relation was found between sutures widths and age among male infants; but in female students this relation was not statistically significant.

In another previous study, the researchers report the appearance of cranial sutures in 53 infants younger than 1 year on MRI scans.¹⁵ They reported that the mean coronal suture widths in their studied infants was 1.2 mm; being 1.4 mm for sagittal suture, and 1.3 mm for lambdoid suture. These findings are different from that find in our study, the sutures widths in the present study were higher than the mentioned study at a lower age but are nearly comparable at a higher age of about 12 months. The difference between both studies can be explained by the difference in assessment method; we reported our results base on CT scans, while in the mentioned study, the findings were based on MIR scans.

In a study by Soboleski *et al.*,¹¹ 50 infants aged between 0 and 5 months undergoing brain sonography were assessed to examine the cranial suture width of the coronal, sagittal, and lambdoid sutures.¹⁰ They reported that the mean coronal, sagittal, and lambdoid suture widths were 0.89, 0.93, and 0.96, respectively. Also, they reported that sutures widths were not correlated with age in their studied population. Unlike the mentioned study, we found a significant negative correlation between age and suture widths in infants under 1 year, also the mean of all sutures widths in our study are higher than that reported in the previously mentioned study. The differences between these findings can be due to different sample sizes (50 infants in Soboleski *et al.* study versus 302 infants in the present study) and assessment method (sonography in Soboleski *et al.* study and CT scans in our study).

Our study has limitations that should be noted. First, premature infants may have been included in the sample population. It is possible that the inclusion of premature infants may distort the measurements of cranial sutures at 0 and 1 month of age but probably did not affect results of the

older age groups. Second, there was a slight male predominance in the study population, so we did not separate the patients by sex. Few anthropologic studies have noted a slight increase in suture width in the adult male population to that of the adult female population;¹⁶ however, an equivalent number of studies did not reach the same conclusion.¹⁷ Third, less number of patients were in a higher age group in our study, and this might have reduced the potential of the study to evaluate the differences between mean suture widths in infants with respect to age groups.

In summary, it is the first study design to derive suture widths on CT in Indian population of infants by the most common technology used today. In the first year of life CT measurements of mean suture widths decrease rapidly. During the first month of life there occurs considerable closure for all cranial sutural measurement followed by gradual decrease in width during the remainder of the first year of life. Based on these data, we elaborated the normal values for the coronal and sagittal sutures width on CT during the first year of life. The suture widths noted by month here provide a quick and reliable means of assessing a patient's suture width against normal values for CT to the radiologists.

Conclusion

The present study provides data about normal suture widths in infants during the first of life by CT scans and the importance of the distinction between normal sutural anatomy and abnormalities, shows the necessity of further studies to evaluate sutures widths and closes in infants under 1 year based on CT scans as the frequent methods to assess infants' head problems. This study provides normal reference values for suture widths established by CT scan among a sample of Indian infant population and it may be used to assess the infant calvaria for suture diastasis.

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Sexual Dimorphism in Adult Human Mandible of South Indian Origin

Zafar Sultana¹, T Sreekanth², S Niveditha³

Abstract

Background: Mandible is the most durable and sexually dimorphic bone of the skull and resists postmortem changes too. Sexual dimorphism is seen in stages of mandibular development, growth rates and duration. Even by simple observation there is clear difference in size, height, thickness and muscle markings of mandible. **Context and purpose:** To establish and compare few metric parameters to assess sexual dimorphism in adult human mandibles of south Indian population. **Methods:** The present study was conducted on 60 dry adult human mandibles collected from anatomy dept of Shadan Institute of Medical Sciences and VRK Womens Medical College, Hyderabad. Only adult intact mandibles were included in study damaged, deformed broken bones excluded from study. First we classified bones depending on morphological features/non-metric parameters into males and females. Non-metric parameters were also recorded. **Results:** The mean bigonial breadth was 93.62 mm in males compared to 80.78 mm in females. Thus it was more in males compared to females and this difference was found out to be statistically significant. The bicoronoid breadth was 91.09 mm in males compared to 84.24 mm in females. Thus the bicoronoid breadth was more in males compared to females and this difference was found out to be statistically significant. Mandibular body height was significantly different for males and females mean for males was 28.13 mm and for females mean was 25.40 mm. Parameters like the mean bicondylar breadth, bimental breadth were not significantly different in males and females. **Conclusion:** The mean bigonial breadth, mean bicoronoid breadth and mandibular body height was significantly more in males compared to females. But other parameters were similar in both the sexes. **Potential implications:** Sexual dimorphism of skull is population specific due to combination of genetic as well as environmental factors. Racial and ethnic differences are also there. These metric data are useful for medicolegal, anthropological and dentofacial surgical procedures also.

Keywords: Sexual dimorphism; Human mandible; South Indian; Bigonial breadth; Bicondylar breadth; Bimental breadth; bicoronoid breadth; Mandibular body height.

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Introduction

Bones play important role to establish identity of an individual and they also help in establishing process of evolution, race and demographic profile.¹

In adult skeleton, sex determination is usually first step of identification process and subsequent methods for age and stature estimation are sex dependent. Mandible is a Latin word which means lower jaw. Mandere means to chew. Thus the word mandible is derived. The mandible is the largest, strongest and lowest bone in the face. This is only bone in skull capable of separate movement. The accuracy of sex determination directly depends on availability of complete skeleton. It is 100 percent with complete skeleton, 95% with pelvis and 90% with skull.²

Mandible is the most durable and sexually dimorphic bone of the skull and resists postmortem changes too. Sexual dimorphism is seen in stages

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of mandibular development, growth rates and duration.³

Even by simple observation there is clear difference in size, height, thickness and muscle markings of mandible.⁴

The knowledge about anatomy of mandible and its variations with age, sex, and race will help physicians, surgeons, medico-legal authorities and anthropologist to give correct interpretation for their diagnostic and surgical procedures in living and identity proof for skeletal remains. Pelvis exhibits greatest sexual dimorphism mandible is second most dimorphic bone. Mandible has horizontally curved body that is convex forward with upper alveolar border bearing teeth and lower border; i.e., base and two broad rami posteriorly bearing coronoid and condyloid process separated by mandibular notch.⁵

Mandibular size and shape affected by variable lifestyle, dietary behavior and racial groups.⁶

In cases like mass disasters where intact skull not available mandible may play vital role in sex determination as it is most dimorphic largest and strong bone of skull.³

Anthropologist use metric and non-metric parameters to study variations in human skeleton, metric parameters are more useful for comparative study.⁵

In present study has been undertaken to establish and compare few metric parameters to assess sexual dimorphism in adult human mandibles of south Indian population.

Materials and Methods

The present study was conducted on 60 dry adult human mandibles collected from anatomy department of Shadan Institute of Medical Sciences and VRK Women's Medical College, Hyderabad.

Only adult intact mandibles were included in study deformed, damaged and broken bones excluded from study

First we classified bones depending on morphological features/non-metric parameters into males and females

Non-metric parameters

Shape of chin-square in males and rounded in females.

Gonial flare-everted in males and inverted in females.

Muscle markings—more prominent in males than females

40 male bones and 20 were females as per non metric parameters

We studied total five parameters in each bone

Bigonial breadth–bgb; straight distance between two gonion [angle of mandible]

Bicondylar breadth–bcd; the straight distance between the most lateral points on the two condyles

Bicoronoid breadth–bcrb; the straight distance between the most lateral points on the two coronoid processes

Bimental breadth–bmb; the straight distance between the inner margins of two mental foramina

Mandibular body height–mbht; it measures the distance from alveolar margin to lower margin of mandible at level of mental foramen perpendicular to base.

The metric parameters were measured using digital vernier callipers, all measurements in mm.

Statistical analysis: The measurements were recorded tabulated and analyzed statistically. Software used for data entry and calculation of mean and SD=Microsoft excel worksheet. Software used for calculation of students *t* test = graph-pad statistical software. *p*-value less than 0.05 was taken as statistically significant.

Results

Table 1 shows comparison of bigonial breadth in males and females. The mean bigonial breadth was 93.62 mm in males compared to 80.78 mm in females. Thus it was more in males compared to females and this difference was found out to be statistically significant ($p < 0.05$).

Table 1 shows comparison of bicoronoid breadth in males and females. The bicoronoid breadth was 91.09 mm in males compared to 84.24 mm in females. Thus the bicoronoid breadth was more in males compared to females and this difference was found out to be statistically significant ($p < 0.05$).

Table 1 shows comparison of various parameters in males and females. The mean bicondylar breadth was 110 mm in males and 109.3 mm in females. Though it was slightly more in males but the difference was not found out to be statistically significant ($p > 0.05$).

The bimental breadth was 43.93 mm in males compared to 43.71 mm in females. It was almost similar and thus statistically also the difference was not found out to be significant ($p > 0.05$).

The mean mandibular body height has shown significant gender difference with mean value of 28.13 mm for males and 25.40 mm for females ($p > 0.05$).

Table 1: Showing Statistical Analysis of All Studied Parameters

Parameters	Mean in, Males N=40 Bones	SD Male N=40	Mean in Female N=20 Bones	SD Female N=20	t-value	p-value	Interpretation
Bigonial breadth	93.62 mm	5.37	80.78 mm	6.88	7.9368	0.0001	Significant
Bicondylar breadth	110.00 mm	5.74	109.30 mm	9.35	0.3505	0.7272	Not significant
Bicoronoid breadth	91.09 mm	4.99	84.24 mm	20.19	2.0404	0.0459	Significant
Bimental breadth	43.93 mm	2.92	43.71 mm	2.13	0.2990	0.7660	Not significant
Mandibular body height	28.13 mm	3.16	25.40 mm	2.94	5.132	0.0001	Significant



Fig. 1: Measurement of bicondylar breadth.



Fig. 2: Measurement of bigonial breadth.



Fig. 3: Measurement of bicoronoid breadth

Discussion

In the present study, we found that the mean bigonial breadth was 93.62 mm in males compared to 80.78 mm in females. Thus it was more in males compared to females and this difference was found out to be statistically significant ($p < 0.05$).

Kumar MP *et al.*⁷ found that the mean breadth of the bigonial was 92.22 mm overall for both the sexes which are comparable to the males in the present study.

Singh R *et al.*³ observed the similar findings as found in the present study; i.e., more mean values of the bigonial breadth in males (96.2 mm) compared to females (84.3 mm) which was statistically significant.

Vinay G *et al.*⁸ also reported similar findings which are comparable to the above two mentioned studies; i.e., more breadth in males compared to the females.

Datta A *et al.*⁹ found in their study that the mean bigonial breadth was 95.7 mm in males and

88.75 mm in females. This difference was found to be statistically significant which is similar to the findings of the present study.

In the present study, we found that the mean bicondylar breadth was 110 mm in males and 109.3 mm in females and obviously the difference was not found to be statistically significant.

Kumar MP *et al.*⁷ did all of their study in male mandibles and reported the mean value as 110.32 mm which is comparable to the findings of the present study.

Singh R *et al.*³ observed that the mean bicondylar breadth in males was 112.2 mm and 101.7 mm in females and this difference was found out to be significant. This finding is in sharp contrast to the findings of the present study. The mean values are also slightly more compared to the present study.

Vinay G *et al.*⁸ also reported that the mean bicondylar breadth in males was 112.72 mm and 107.48 mm in females and this difference was found out to be significant. This finding is in sharp contrast to the findings of the present study. The

Table 2: Showing Comparison With Previous Authors for Bicornoid Breadth

Author	Bicornoid Breadth in Males, Mean	Bicornoid Breadth in Females Mean	Bicornoid Breadth S.D\Males	S.D Females	t-value	p-value	Interpretation
Kumar MP <i>et al.</i> , ⁵⁰ Bones	91.97 mm		5.69				
Sarvesh Kumar <i>et al.</i> 53 Bones	94.88 mm	90.92 mm	0.613	0.41155		<0.05	Significant
Kanchankumar <i>et al.</i> , 82 Bones	95.3 mm	91.3 mm	0.065	0.113			
Present study	91.09 mm	84.24 mm	4.99	20.19	2.0404	0.0459	Significant

mean values are also slightly more compared to the present study.

Bimental breadth in our study not showing any significant gender difference. Kumar MP *et al.*⁷ studied 80 adult mandibles; in their study bimental breadth was significantly different in males and females. Study of Anupam Datta *et al.*⁹ done on 50 mandibles, for bimental breadth shows significant gender difference with *p*-value of 0.042.

Study done by Kranioti EF *et al.*¹⁰ on Greek mandibles observed that mean value of bimental breadth in males was 44.55 mm and in females 43.82 mm but the difference was not statistically significant. Study done by Pillaji TJ *et al.*¹¹ for bimental breadth was statistically significant.

In the present study we found that the mean bimental breadth was 43.93 mm. Kumar MP *et al.*⁷ in their study found that the mean bimental breadth was 43.19 mm which is comparable to the

findings of the present study. Datta A *et al.*⁹ in their study found that the mean bimental breadth was 44.38 mm which is comparable to the findings of the present study. The mean bicoronoid breadth is found to be 91.09 mm in the present study and this was found to be comparable with the study by Kumar MP *et al.*⁷ (Table 2).

In the present study we found that the mean mandibular height has shown significant difference in male and female values. Table 3 shows comparison with other studies.

Anupam Datta *et al.*⁹ in their study found that the mean mandibular height was 28.65 mm which is comparable to the findings of the present study (Table 3).

Sikka *et al.* in their study has shown significant gender difference with mean value of 24.9 mm for males and 22.8 mm for females, (*p* > 0.05).

Table 3: showing Comparison with Other Authors for Mandibular Body Height

Author	Mandibular Body Height, Mean In Males	Mandibular Body Height Mean, Females	SD Male	SD Female	t-value	p-value	Interpretation, Range Min-Max.
Sikka <i>et al.</i>	24.9 mm	22.8 mm	0.46	0.42		<0.01	Significant
Deepak N Kawale <i>et al.</i>	23.95 mm	22.83 mm	0.409	0.3091		0.235	Insignificant
Anupam Datta <i>et al.</i>	28.65 mm	22.83 mm	2.58	3.73	6.415	0.0001	25.03–34.51M 14.81–29.23 F Significant
Present Study	28.13 mm	25.40 mm	3.16	2.94	5.132	<0.0001	18.05–36.00 M 17.342–32.35 F Significant

Conclusion

Sex determination from bones is an important part of study in forensic medicine. Sex determination from skeletal remains is very important to establish identity in medico-legal cases. Mandible is second most dimorphic bone after skull to show sexual dimorphism. The advantage of metric analysis is that the data obtained can be easily comparable with different studies. Five parameters we studied in south Indian population, bigonial breadth of mandible. Bicornoid breadth and mandibular body height have shown significant gender difference comparable with other studies. Bimental breadth, bicondylar breadth has not shown significant gender difference. Sexual dimorphism of skull is population specific due to combination of genetic as well as environmental factors. Racial and ethnic differences are also there. These metric data is useful for dentofacial surgical procedures also.

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Morphometric Study of Acetabulum in Adult Dry Human Pelvic Bone

Ilankathir Sridharan¹, Sudagar Muthusamy², Rajan Thangarasu³, Sridhar Krishnamoorthy⁴, Sowmiya Ganesan⁵

Abstract

Background: Acetabulum together with the head of the femur forms the hip joint. Major defect involving the joint space needs to be reconstructed. Variations in acetabular dimensions remain a challenge for the surgeons during arthroplasty. Adequate knowledge about the various morphometric parameters of the acetabulum may assist them to deliver the best results by preferring prosthesis with appropriate dimensions. **Aim of the Study:** To study the morphometric measurements of Acetabulum from the adult dry human pelvic bone. **Materials and Methods:** The present study was carried out in the Department of Anatomy, Aarupadai Veedu Medical College and Hospital, Puducherry, Vinayaka Missions Research Foundation. The study sample consisted of 120 Human dry pelvic bones consisting of 60 right and 60 left sides. Classification of the bones regarding gender was not carried out. All the bones without any defect to the acetabulum were preferred for this study. **Results:** Mean diameter of the acetabulum was 50.43 ± 3.88 mm on the right side and 50.28 ± 3.85 mm on the left side. Mean depth of acetabulum was 24.34 ± 2.53 mm on the right side and 24.35 ± 2.54 mm on the left side. The mean width of the acetabular notch on the right side was 24.48 ± 1.89 mm and 24.29 ± 1.86 mm on the left. The mean diameter of the acetabulum on the right side is greater than the left. The mean depth on the right and on the left shows the only meager difference. The mean notch width on the left side is comparatively less than that on the right side. **Conclusion:** Morphometric values of the acetabulum compared on both sides provides adequate knowledge for the orthopedic surgeons to determine the appropriate size of the prosthesis during hip arthroplasty. Further studies involving gender may provide additional information to validate their surgical procedures.

Keywords: Morphometric measurements; Acetabulum; Reconstruction.

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Introduction

The hip joint, a three-dimensional ball and socket type of synovial joint usually formed by the

articulation of acetabulum (socket) of the hip bone and the head of the femur (ball). The acetabulum of the hip bone lies bilaterally and tries to occupy the lateral aspect of the hip bone very much close to the center, facing downwards, forwards and laterally. The three innominate bones of the hip bone namely the ilium, ischium, and pubis contribute unequally to form the acetabulum.¹ The limbus of the acetabulum presents with irregular projections all around except inferiorly to form the acetabular notch. The earlier also provides attachment to fibrocartilaginous acetabular labrum to deepen the cavity. Though the acetabulum is deepened but fails to enclose the femoral head completely making it an incongruous type of joint. The cavity of acetabulum includes two areas²—articular (Lunate surface) and non-articular (Acetabular fossa).

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Acetabular morphometric parameters like depth of the cavity, diameter and acetabular notch width in addition to various morphological parameters like an anterior acetabular ridge, end of the lunate surface along with the head of the femur determine the stability of the joint. Any cause affecting any one or multiple parameters will lead to deterioration in the stability, leading to conditions like acetabular dysplasia, pincer femoroacetabular impingement and osteoarthritis, and even fractures. Earlier interventions like periacetabular osteotomy, acetabular recontouring are required to overcome these clinical conditions.^{3,4} Recent advances like prosthetic replacement of acetabulum have carried the expected outcome to the next level. But surgical errors like malpositioned acetabular component in partial/total hip arthroplasty may lead to dysplasia,⁵ restricting the available range of movement, and even osteolysis. To overcome these surgical errors, appropriate selection of acetabular prosthesis size and proper positioning is a must. Though both morphology and morphometry of acetabulum carry equal importance in the selection of prosthesis, controversies still exist with surgical procedures. As a supportive measure, various dimensions that determine the prosthesis size of acetabulum like the diameter of the acetabulum, its depth and width of the acetabular notch were preferred for this study and to determine whether there exist any differences in anatomical parameters with respect to change inside.

Materials and Methods

The present study was carried out in the Department of Anatomy, AarupadaiVeedu Medical College and Hospital, Puducherry, Vinayaka Missions Research Foundation. The study sample consisted of 120 Human dry hip bones consisting of 60 right and 60 left sides. Specimens which retained its morphological features and in good condition after dissection from cadaver were only used for this study. Specimens with osteoarthritis of the hip, evidence of trauma or any other skeletal disorders were excluded. Gender classification of the samples was not carried out. Morphometric parameters like the diameter of the acetabulum, its depth, and width of the acetabular notch were evaluated.

The diameter of Acetabulum

The diameter of the acetabulum is measured using the following reference points:

Reference point 1: junction where anterior iliac margin meets the periphery of the acetabulum.

Reference point 2: a point on the periphery of the acetabulum nearest to the ischial tuberosity.

Inter distance between these references corresponds to the diameter of the acetabulum (Fig. 1).



Fig. 1: Shows the measurement of the diameter of the acetabulum.

Depth of Acetabulum

A metal scale was placed across the diameter of the acetabulum representing the horizontal plane and stem of the vernier scale was later placed from the deepest point of the acetabular cavity. The vertical distance between their intersections determines the depth of the acetabulum (Fig. 2).



Fig. 2: Shows the measurement of depth of the acetabulum.

Width of Acetabular notch

The width of the acetabular notch was determined by the Inter distance between the ends of the lunate surface of the acetabulum (Fig. 3).

All the dimensions were recorded in millimeters and were analysis was carried out comparing the dimensions bilaterally and between genders.

The data obtained were processed using Microsoft Excel software – version 2007. Statistical analysis was carried out using Student's t-test and Pearson correlation test.

Statistical Analysis

The data obtained for depth was tabulated and analyzed statistically to find Mean, Standard deviation (SD) and Range in both the sexes and both the sides. The results were analyzed statistically, by unpaired Student's 't' test. *p*-value of <0.05 was considered for Statistical significance. Statistical analysis was done using SPSS (Statistical Package for the Social Sciences) version 19 and Microsoft Excel 2007.



Fig. 3: Shows the measurement of the width of the acetabular notch.

Results and Discussion

This study would be helpful for the surgeons to determine the appropriate dimension for the acetabular prosthesis during total/hemiarthroplasty. In the present study, the mean diameter of the acetabulum on the right side is

50.43 mm and on the left side, it is 50.28 mm. The mean depth on the right is found to be 24.34 mm and on the left, it is 24.35 mm. The mean width of the acetabular notch on the right side is 24.48 mm, whereas on the left it is 24.29 mm, except the depth all the other parameters showed higher values on the right compared to the left. The value when compared with that of Gursharan Singh Dhindsa,⁶ the diameter on the right side 5.13 cm is slightly higher but on the left side 5.03 cm, coincides with his study. The values of the depth on both right and left are comparatively less than his values which are 2.67 cm and 2.64 cm. The values of the diameter and depth were comparatively less than that of Lander *et al.*,⁷ where diameter found to be 5.70 cm on the right, 5.60 cm on the left and the depth found to be 2.75 cm and 2.82 cm respectively. Values of the diameter of this present study were found to be greater when compared with that of Chauhan *et al.*,⁸ which is 4.71 cm and 4.75 cm respectively, but the values of the depth being 2.47 cm on right and 2.57 cm on left coincides with our present study. Similarly, the values meet the findings of Kareddy Pratibha *et al.*,⁹ the diameter being 4.85 cm, 4.74 cm, and depth 3.0 cm, 3.06 cm respectively. The mean depth on the right is 26.24 mm and 26.11 mm on the left which is greater than that of reported by Khobragade L *et al.*¹⁰ The values of the diameter and the depth were comparatively less than that of the report by Funda Tastekin where the average diameter is 54.29 ± 3.8 mm and the depth being 29.49 ± 4.2 mm but greater than that of Gaurang parmara *et al.*,¹¹ average diameter being 42.54 ± 3.6 mm and average depth being 19.07 ± 2.47 mm. The value of the mean notch width is comparatively greater than

Table. 1: Morphometric Parameter in Dry Acetabulum (N=120)

Sr. No	Morphometric Parameters	Side	Number	Mean (mm)	SD	t-value	p-value
1.	Diameter of Acetabulum	Right	60	50.43	3.88	0.148	0.883
		Left	60	50.28	3.85	0.309	0.760
2.	Depth of Acetabulum	Right	60	24.34	2.53	2.585	0.015
		Left	60	24.35	2.54	2.299	0.029
3.	Width of Acetabular Notch	Right	60	24.48	1.89	0.148	0.883
		Left	60	24.29	1.86	0.030	0.977

that of Gangavarapu Sreedevi *et al.*,¹² reported on the right to be 22.25 mm and on the left to be 22.52 mm, but comparatively less than that of Yugesh *et al.*¹³ were it is 30.8 ± 0.42 mm and 31.1 ± 0.72 mm respectively.¹³

Conclusion

Mean diameter of the acetabulum was 50.43 ± 3.88 mm on the right side and 50.28 ± 3.85 mm on the left side. Mean depth of acetabulum was 24.34 ± 2.53 mm on the right side and 24.35 ± 2.54 mm on the

left side. The mean width of the acetabular notch on the right side was 24.48 ± 1.89 mm and 24.29 ± 1.86 mm on the left. Adequate knowledge about the morphometric parameters of the acetabulum is required for any reconstructive procedures of the hip joint resulting from mechanical damage to the structures concerned. The reports of this study provide only the data with reference to varying insides. Further studies involving the difference in gender may help the surgeons to gain more detailed knowledge and other researchers to compare with their studies.

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