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Original Article

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Ultrasonogrphic Estimation of Birth Weight by Measuring Biparietal Diameter and Abdominal Circumference in High Risk Pregnancies

Rupali S. Kavitake*, Mehera Bhoir, M.V. Ambiye*****

Abstract

Background: When delivery of a preterm infant is anticipated accurate antenatal assessment of the fetal weight can be a useful adjuvant for establishing a plan of management .That will minimize perinatal morbidity and mortality rate. *Objective*: To estimate fetal birth weight by measuring fetal abdominal circumference and biparietal diameter in 3rd trimester high risk pregnancies by Ultrasonography. To devise a simple and accurate equation for estimating birth weights of preterm and low birth weight fetuses. *Methods and material*: The study population was made up of 92 high risk 3rd trimester pregnant patients. Fetal measurements were made by real time USG machine. *Result*: In the present study estimated fetal birth weight calculated by Gray Thurnau's equation formula was highly correlated with actual birth weight with correlation coefficient of 0.925. *Conclusion*: Abdominal circumference and biparietal diameter are the best indicators to assess birth weight in high risk pregnancies.

Keywords: Fetal Birth Weight; Ultrasonography; Abdominal Circumference and Biparietal Diameter.

Introduction

'There is no indicator in human biology which tells us so much about the past events and future trajectory of life, as the weight of the infant at birth. - V. Ramlingaswami.

Birth weight is the single most important marker of adverse prenatal, neonatal and infantile outcome. Over 80% of all neonatal deaths in both developed and developing countries occur among low birth weight babies.

About 25-35% of babies in India are low birth weight. Out of these 10-12% babies are born preterm as compared to 5-7% incidence in West [6].

A simple and accurate method of estimating fetal birth weight, which would be applied to all pregnancies, would be an important means of reducing perinatal mortality and morbidity [1].

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Ultrasound being a painless, non- invasive inexpensive and apparently harmless technique has the potential to be used to screen all obstetric patients. So important is its role, that many countries have adopted to perform at least three scans per pregnancy for an individual (i.e. one scan in each trimester) [5].

Serial measurements have been used successfully to detect fetal growth retardation. But this technique would not be feasible for our Indian population at large especially in the rural areas. Hence a single early scan measuring Crown- Rump length or Biparietal diameter would tell us the accurate menstrual age and a late scan in 3rd trimester would help in assessing the expected fetal birth weight by taking abdominal circumference into consideration. It has been found that fetal abdominal circumference is a reliable, quick and simple method for estimating fetal weight on a large scale.

Accurate estimation of fetal weight is important for the reduction of perinatal morbidity and mortality.

Materials and Methods

The study population was made up of 92 high risk 3rd trimester pregnant patients with history of

1. Pre-eclampsia

2. Ante partum hemorrhage
3. Multiple pregnancy
4. Polyhydramnios
5. Oligohydramnios
6. Bad obstetric history
7. Medical disorders
8. Previous preterm delivery
9. Low socio economic and nutritional status
10. Addictions: Alcohol consumption, smoking

After the permission from the institutional ethics committee, the study data was obtained from high risk pregnant patients who have delivered within two weeks of ultrasonographic examination. The proforma was made. Informed consent was obtained from the women to use examination data in study.

Fetal measurements were made by real time USG machineFirst, the position, lie and presentation of fetus were seen.

The axial section was recognized when shape of the fetal skull was ovoid and the midline echo from the falx cerebri was interrupted by cavum septi pellucidi and the thalami. When this plane was found, the gain on the ultrasound unit was reduced to avoid the artifactual thickening of skull tables. Measurement was made from the outer table of the proximal surface of the skull to the inner table of the distal surface of the skull. The soft tissues over the skull were not included. This is called as leading edge to leading edge technique. The biparietal diameter was measured with an electronic caliper.

The biparietal diameter measurement was followed by displacing and moving the transducer on the maternal abdomen so as to find the fetal craniovertebral junction and the vertebral column of fetus was traced to its termination. A projection was found that showed a transverse section of one of the long bones. Then the scan was turned by 90 degrees to that to obtain a longitudinal section. The fetal body was then followed till the heart was reached and moving along the fetal body until the fetal urinary bladder was imaged. This was followed by the image of iliac crests; they appeared as two short bright echoes along the bladder. A short distance further, a bright echo appeared close to iliac crest, which was the femur. On rotation, the femoral echo increased in length. The full length was demonstrated when the femur cast an acoustic shadow, which was sufficient to conceal the posteriorly lying structures. Measurement was made from one end of the bone to other end. In case of any doubt the other limb can also be measured.

Abdominal circumference was measured at the level of fetal liver, which is very sensitive to deficient nutrition. The measurement was made as a true transaxial plane, where the umbilical portion of the left portal vein enters the liver [9].

With these parameters estimated fetal birth weights were calculated by Gray Thurnau's equation one (E_1) and compared with their actual birth weights.

Observations

Equations for estimating fetal birth weight

[a]% $\mathbf{E_1}$ ® EFW = (BPD x AC x 9.337) – 299.076

Where,

EFW = Estimated foetal weight

AC = Abdominal Circumference

BPD = Biparietal diameter

ABW = Actual Birth Weight

Table 1: Mean and sd of patients age (yr) and gestational age (wk)

Sex of Neonate	No of Cases	%
Male	43	47
Female	49	53
Total	92	100

Table 2: Sex distribution

Variable	Mean ± sd
Fetal bpd(cm)	8.02 ± 0.58
Fetal ac(cm)	27.7 ± 2.8

Table 3: Mean and sd of sample population measurement variables (n=92)

Variable	Mean ± SD
Fetal bpd(cm)	8.02 ± 0.58
Fetal ac(cm)	27.7 ± 2.8

Table 4: Mean and sd of estimated fetal birth weight and actual birth weight (n = 92)

	Mean ± SD
ABW(gm)	1809 ± 374
E_1(gm)	1791± 348

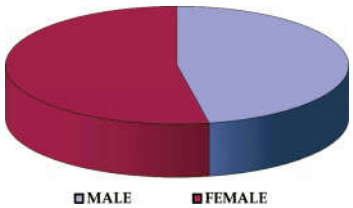
Table 5: comparison of estimated fetal birth weight, actual birth weight and sex of neonate

Sex	EFW(gm) E_1	ABW(gm)
Male	1826	1834
Female	1761	1786
P value	> 0.005	> 0.005

Thus the sex of the infant at delivery was not a statistically significant factor for difference between estimated and actual birth weight.

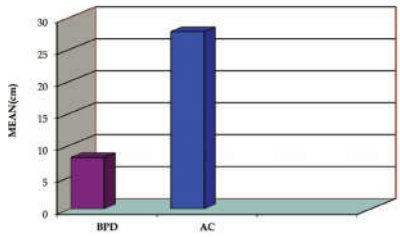
Table 6: Correlation matrix of sample population measurement variables

	BPD	AC	E1	ABW
BPD	1			
AC	0.807	1		
E1	0.925	0.965	1	
ABW	0.810	0.911	0.925	1



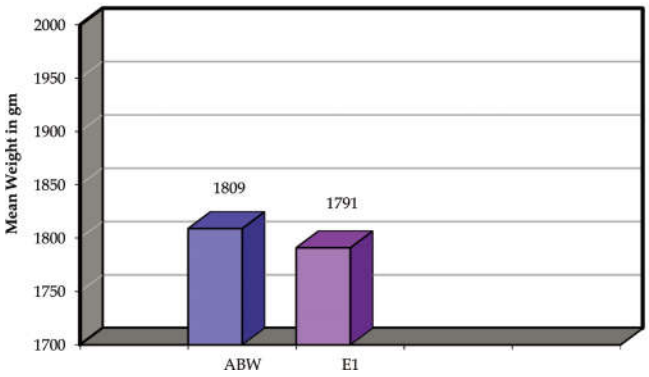
Sex Distribution

Mean of Variables

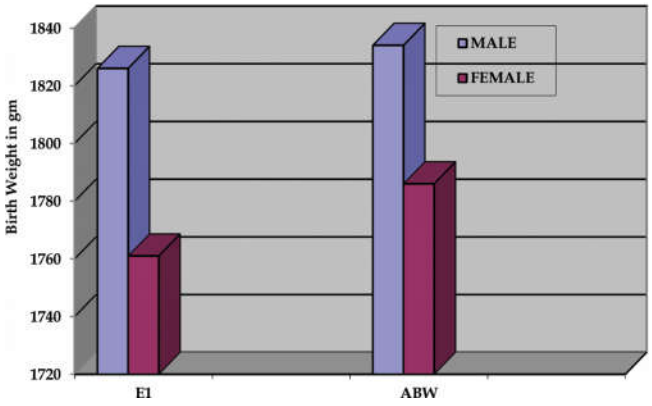


Variables

Mean of Estimated Birth Weight By E_1 and Actual Birth Weight



Mean of Estimated Birth Weight and Actual Birth Weight in Male and Female Infants



Neonatal actual birth weight was highly correlated with each of the other two measurement variables with the highest value being that for ABW and AC. ($p<0.001$)

Discussion

The objective of the present study was to develop a mathematical equation that is simple accurate and easy to use when applied to preterm and low birth weight fetuses. In this study real time ultrasound measurement of fetal biparietal diameter, abdominal circumference and femur length were obtained in 92 pregnant women within two weeks of delivery. The parameters used in this study are discussed one by one

Biparietal Diameter

The fetal BPD was the first sonographic parameters used to determine gestational age and assess fetal growth.

Routine single measurement of the BPD early in 2nd trimester have been shown to be an accurate method of assessing the menstrual age of the fetus (Campbell [3] 1974) but single measurements in late pregnancy are not clinically useful in assessing birth weight (Campbell[4]1973). Serial measurements have been used successfully to detect fetal growth retardation (Willocks et al [14] 1969, Campbell and Dewhurst [2]1971, Varma [13] 1973).

But this technique can not be used to screen all obstetric patients due to the excessive work load which this would entail [5].

Rudy Sabbagha et al [10] in 1976 obtained serial BPD readings and categorized them into three percentile rankings. And for the first time they reported that under normal condition fetuses initially placed in any of these three cephalic levels will continue to grow within the confines of the same percentile range.

In the present study the mean biparietal diameter was 8.02 cm with SD 0.58.

Abdominal Circumference

Abdominal circumference is the most sensitive predictor of fetal weight and this is to be expected because it reflects the glycogen store of the liver. It is also an easier measurement to obtain compared to those of the head whose size, shape and accessibility will be altered according to where it is positioned. Abdominal circumference increases approximately by 20 mm in 2 wks in the average fetus. Several workers have achieved greater success in predicting birth weight from single examination by linear (Thompson and Makowski 1971) or circumference (Levi 1972, Hansmenn et al 1973) measurement of fetal thora [1].

Campbell [7], 1974 have found that the greatest

accuracy in prediction is achieved by taking circumference measurements of fetal abdomen at the level of umbilical vein. In 1975 Campbell [5] did prospective study and showed that the accuracy of predictions varied with the size of the fetus at a predicted weight of 1kg, 95% of birth weight fall within 160gm, while at 2 kg, 3kg and 4kg the corresponding values are 290 gm, 450gm and 590gm respectively.

W.D. McCallum et al [7] in 1979 reported multiple regression analysis of birth weight and the natural logarithm of birth weight against several measured variables. The formula giving best correlation was a polynomial regression of the natural logarithm of birth weight versus trunk circumference and a long axis measurement. The best correlation was 0.944 giving predicted birth weight error of ± 103 gm of SD.

In the present study the mean abdominal circumference was 27.7 cm with SD 2.8cm. Abdominal circumference is highly correlated with BPD and actual birth weight.

Milo B. Sampson et al [11] in 1982 compared five different equations and concluded that actual birth weight correlated best with the predicted weight when Warsof's equations was used to calculate predicted weight from AC and BPD.

Thomas C. Key et al [5] did prospective study to compare two formula reported by Warsof et al and Shepard et al and they concluded that with Warsof's formula there was a high degree of correlation between estimated fetal birth weight and the actual birth weight (r-0.9 82, P<0.001).

In the Present Study Equation one (E_1) was Based on Gray Thurnau's Equation (1983)

Gray Thurnau et al (12) in 1983 did prospective study. They obtained real time ultrasound measurement of BPD and AC in 62 pregnant women prior to one week of delivery. When predicted estimated fetal weight was compared with actual birth weight multiple regression analysis demonstrated a correlation coefficient of 0.957. They also proved that AC was highly correlated with actual birth weight. AC, BPD were also highly correlated with each other.

In the Present Study Estimated Fetal Birth Weight Calculated by Formula E_1 was Highly Correlated with ABW with Correlation Coefficient of 0.925

Michael T. Medchill [8] in 1991 compared the actual birth weight of low birth weight infants with the estimated fetal weight derived from 20 published formulas. They concluded that Rose's formula was better and showed the smallest SD and better correlation (69gm and 0.780 respectively).

Using this formula 46 of 63 (73%) of the estimated fetal weight were within 10% of the actual birth weight and 56 of 83 (89%) were within 100gm of birth weight.

In the present study 72 of 92 (78%) of estimated fetal weight were within 10% of actual birth weight by using equation E_1.

Statistical analysis showed that by using 't' test there was no statistical difference between means of estimated fetal birth weight calculated by formula E_1 and actual birth weight.

Conclusion

In the present study formula E_1 is more accurate predictor of birth weight in high risk pregnancies when the Pearson's coefficient, standard deviation, percent error and't' test were used for comparison.

The conclusions of the present study are:

1. Abdominal circumference and biparietal diameter are the best indicators to assess birth weight in high risk pregnancies.
2. Fetal birth weight calculated by formulaEFW = (BPD ×AC× 9.337) – 299.076 is accurate for high risk pregnancies. This simple equation appears to be clinically reliable and easy to use when estimating weights of preterm or low birth weight fetuses.

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Original Article

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Duplication of Inferior Vena Cava

Anupama Chauhan*, Shobha Rawlani, Bharat Sontakke*, Shivlal Rawlani*****

Abstract

Double inferior vena cava is rare congenital variation resulting from the persistence of the embryonic cardinal venous system. Duplication of inferior vena cava is rare occurrence where the left side cardinal venous system persists as the left inferior vena cava.

This study was carried out in the Department of Anatomy, Dr. P. D. M. M. C. Amravati. Total thirty male adult cadavers were dissected to study the inferior vena cava. Out of thirty, in one cadaver, the duplication of inferior vena cava was observed. This anomaly was discussed along with its embryological basis. Apart from duplication of inferior vena cava, no any other anomaly was found.

Keywords: Inferior Vena Cava; Congenital Variation; Duplication.

Introduction

The inferior vena cava is formed by the union of right and left common iliac veins 11 slightly below the level of bifurcation of the aorta, in front of body of fifth lumbar vertebra, about 2.5 cm to the right of the median plane. It conveys the venous blood to the right atrium from all parts of the body below the diaphragm [1]. The inferior vena cava develops during fifth to seventh week of development from many sources [2]. An anomaly of inferior vena cava is not infrequent and has been estimated to occur in only about two to three percent of persons [11].

An accurate preoperative diagnosis can be made if computed tomography assessment of vascular structure is made by using intravenous contrast material during the arterial phase [3]. Not only the Radiologist but also surgeons dealing with this regions must also be familiar about this anomalies, as high index of suspicion on the surgeons required to prevent inadvertent injury to these anomalous veins and to avoid significant hemorrhage during retroperitoneal surgery [4,8,9].

Detailed knowledge of these anomalies is crucial for inferior vena cava filter placement .spermatic vein embolization, and adrenal or renal venous sampling [10]. Anomalies of the inferior vena cava and renal veins occur infrequently but unidentified can lead to significant morbidity during surgical exploration [11].

Materials and Methods

The present study was carried out in the Department of Anatomy, Dr. P. D. M. M. C. Amravati. Total thirty adult cadavers were dissected for study of the inferior vena cava, out of which in one cadaver, the duplication of inferior vena cava was observed. Apart from duplication of inferior vena cava, no any other anomaly was found.

Results

In present study, it was observed that the right and the left common iliac veins were joined on the right side of abdominal aorta at the level of fifth lumbar vertebra to form the inferior vena cava which ascended up on the right side of abdominal aorta.

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There was another abnormal venous channel (referred as duplicated inferior vena cava) arising from the left common iliac vein which ascended up parallel to the left side of abdominal aorta. This abnormal venous channel ended by draining into the left renal vein. Left phrenic vein also drained into left renal vein whereas left suprarenal vein drained into left phrenic vein, instead of draining into the left renal vein normally. Left gonadal vein was opening into the left renal vein close to this abnormal venous channel, that the duplicated inferior vena cava.

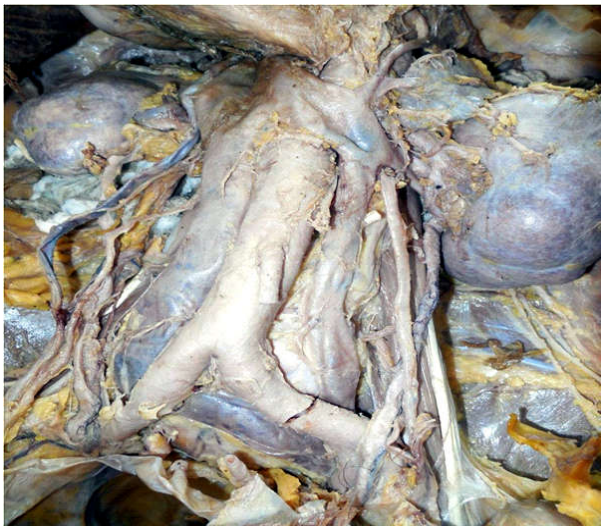

Fig. 1: Showing duplicated inferior vena cava Lt to aorta

Discussion

Embryological Basis of Doubling of Inferior Vena Cava

The inferior vena cava develops during fifth to seventh week of development from many sources like right posterior cardinal vein, right supracardinal vein, right subcardinal-supracardinal anastomosis, right subcardinal vein, subcardinal hepatocardiac anastomosis and right hepatocardiac channel. Any deviation in this complex process of embryogenesis may lead to variations in the inferior vena cava. So anomalies of inferior vena are produced as consequence of its complicated mode of development.

Duplication of the inferior vena cava results from persistence of both sided supracardinal veins[2]. In present study, it was observed that the right and the left common iliac veins were joined on the right side of abdominal aorta at the level of fifth lumbar vertebra to form the inferior vena cava which ascended up on the right side of abdominal aorta. There was another abnormal venous channel (referred as duplicated inferior vena cava)arising from the left common iliac vein which ascended up parallel to the left side of abdominal aorta.(Fig.1). This abnormal venous channel ended by draining into the left renal vein. Left phrenic vein also drained into left renal vein whereas left suprarenal vein drained into left phrenic vein, instead of draining into the left renal vein normally.

Left gonadal vein was opening into the left renal vein close to this abnormal venous channel, that the duplicated inferior vena cava (Fig. 1). Bass J E et al . reported many congenital anomalies of inferior vena cava like left sided inferior vena cava, azygous continuation of inferior vena cava, absence of the infrarenal inferior vena cava or the entire inferior vena cava, also reported double inferior vena cava as like us which is 0.2 to 3 percent prevalent [3].

According to the Bass J E et al., two common iliac veins failed to unite at the level of the aortic bifurcation. The two venae cavae ascend on both sides of the aorta. The left inferior vena cava drains into the left renal vein. The left renal vein crosses anterior to the aorta to form the normal right prerenal inferior vena cava. This arrangement of the left renal vein crossing anterior to the inferior vena cava to form normal right prerenal inferior vena cava is the commonest arrangement in the duplication of inferior vena cava [3].

According to Klimberg and Cohen et al., duplication of the inferior vena cava is one such relatively rare condition which in majority of cases is clinically silent and diagnosed incidentally by imaging (including computed tomography and magnetic resonance imaging) done for other reasons. This anomaly has significant clinical implications.

Radiologically, the presence of double inferior vena cava can be mistaken as a pathological lesion such as lymphadenopathy [5]or left pyelo-ureteric dilatation [6]. The presence of double inferior vena cava may also complicate the retroperitoneal surgery. The double Inferior vena cava can be inadvertently injured or ligated during retroperitoneal surgery [6]. Variations in the inferior vena cava are hence indicative of defective angiogenesis and are of immense surgical importance especially in retroperitoneal surgeries and in cases of thromboembolism.

Complexity of embryogenesis of the inferior vena cava, accounts for the great diversity in its anomalies. Among the most common anomalies, incidence are 0.69% in left sided inferior vena cava, 1.03% in double inferior vena cava, and 0.08% in azygous continuation. The knowledge of anomalies of inferior vena cava is important in both diagnostic and operative purposes. The modern techniques like CT scan and MRI have helped the doctors to diagnose its variations [7] .

The vast variability of the overall rare congenital anomalies of the IVC is mostly detected through different imaging modalities. These variations cannot be classed as pathological findings, and should not be confused with lymphomas and has to differ from secondary collateral venous pathways. Knowledge of caval anomalies can prevent misinterpretation of mediastinal masses, iliac occlusion with venouscollaterals, or Para vertebral lymph node

Conclusion

One should be aware of double inferior vena cava as a rare anatomical variant that may have significant surgical implications. If double inferior vena cava is not preoperatively recognized, it can be a source of severe surgical complications.

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Foramen Ovale: Morphometery & its Surgical Importane

Zuberi Hussain Riyaz*, Azhar Ahmed Siddiqui**

Abstract

Aims: The study of foramen Ovale is of great surgical importance in procedures like percutaneous trigeminal rhizotomy for trigeminal neuralgia, electroencephalographic analysis for seizure and diagnostic transfacial fine needle aspiration technique in perineural spread of tumour. Localization of the foramen ovale can be difficult due to imaging quality (improved by biplanar radiology systems), operator inexperience and anatomical variations. *Methods and Material:* The present study was conducted on 38 dry adult, human skulls of unknown sex obtained from Bone Bank of the Department of Anatomy, IIMSR, Warudi, Jalna. In this study, presence of anatomic variations in shape of foramen ovale was noted. The length and width of foramen were measured. Comparison between right and left was done. *Results:* Mean length of foramen ovale was 7.27mm and mean width was 3.18mm. There was no statistical significant difference between means of the length and width of the right and left sided. It's shape was typically oval in 19, almond in 10, round in 6 and slit like in 3 skulls. *Conclusions:* These anatomical variations in size and shape of foramen ovale should be borne in mind during the surgical and diagnostic importance around the foramen ovale.

Keywords: Foramen Ovale; Foramena of Skull; Anatomical Variation.

Introduction

The foramen ovale (FO) lies medial to the foramen spinosum and lateral to the foramen lacerum on the infratemporal surface of the greater wing of the sphenoid bone. It transmits the mandibular division of the trigeminal nerve, the lesser petrosal nerve, the accessory meningeal branch of the maxillary artery and an emissary vein which connects the cavernous venous sinus to the pterygoid venous plexus in the infratemporal fossa. It passes through the greater wing of the sphenoid posterior to the lingula and posterior end of carotid groove [1].

Foramen ovale is an important constituent of cranial anatomy with high significance in neurosurgery as it enables access to the trigeminal nerve. Thus knowledge of its position is clinically important in the event of anaesthesia of the mandibular nerve as well as in cases of assessment of skull base asymmetries where these foramina measurements become important [2].

Several studies have shown that right side foramen ovale is narrower than left side. It has been hypothesized that entrapment of mandibular nerve when it cross FO is a primary cause of Trigeminal neuralgia (TN) and accounts for the higher incidence of TN on the right side [3]. Anatomical knowledge of the foramen ovale is important for neurosurgical procedures involving the Trigeminal neuralgia and administration of anaesthesia via mandibular nerve [4]. Moreover percutaneous biopsy of cavernous sinus is also performed through FO [4,5].

The present study was undertaken to define anatomical variations in FO and review the literature regarding the same. Prior knowledge of variations in FO may be important for academic, anthropological, forensic and clinical purpose, hence this study aims to highlight such variations [4].

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Material and Methods

The materials for the present study include 38 dry adult human skulls of unknown sex obtained from Bone Bank of the Department of Anatomy, IIMSR, Warudi, Jalna. The posterior part of greater wing of sphenoid was carefully examined for the existence of FO and its patency was confirmed by inserting a probe through. Skulls in poor conditions or skulls with partly damaged surroundings of the FO were omitted from the study. Maximum length (Anteroposterior diameter) and width (transverse diameter) of foramen ovale were measured with help of compass aesthesiometer as shown in Fig.1. Variations in right and left side in length and width were calculated and the variations in shape also recorded as oval, almond, round and slit like.

Observation

In the present study, the mean length of FO was 7.27 ± 1.184mm on right side and 7.46 ± 1.13 mm on left side. Whereas the observed maximum and minimum length was 9.0 mm and 3.0 mm on right side while 9.5 mm and 4 mm on left side. However, the difference between the length of right and left side, was statistically not significant. The Maximum width of FO was 5 mm on both sides, while the minimum width of right and left side was 2.0 mm and 2.5 respectively, (Table 1), and the mean width on right side was 3.18 ± 0.62 mm and 3.244 ± 0.75 mm on left side which is statistically insignificant. Shape of foramen ovale was also observed. It was typically oval in 36 sides (19 right & 17 left), almond in 22 sides (10 right & 12 left), round in 12 sides (6 right & 6 left) and slit like in 6 (3 right & 3 left) (Table-2).

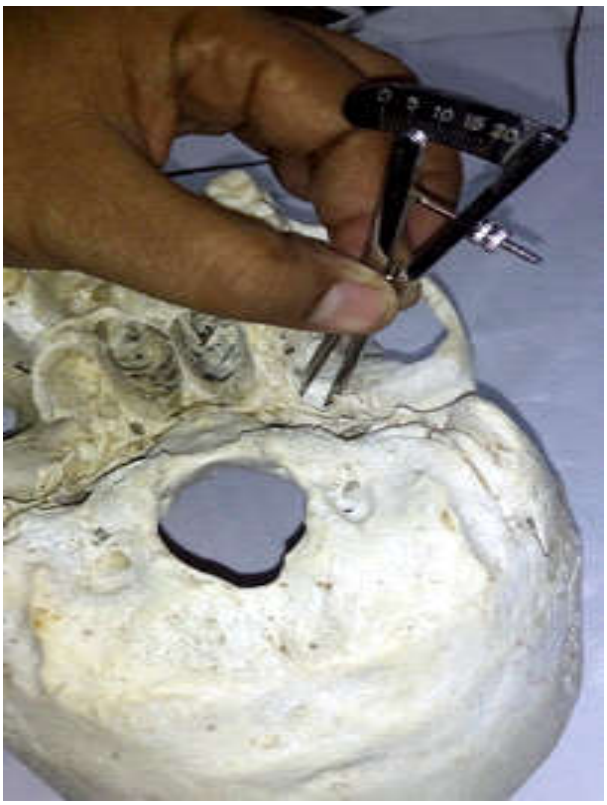

Fig. 1: Measurement of foramen ovale with the help of Compass Aesthesiometer

Table 1: Dimensions (in mm) of foramen ovale in right and left side

Values	Length(right)	Length(left)	Width(Right)	Width(left)
Maximum	9	9.5	5	5
Minimum	3	4	2	2.5
Mean	7.27	7.46	3.18	3.21

Table 2: Variations in appearance of foramen ovale

Shape	Right (n=38)	Left (n=38)	Total (n=76)
Ovale	19(50.00%)	17(44.73%)	36(47.36%)
Almond	10(26.31%)	12(31.57%)	22(28.94%)
Round	6(15.78%)	6 (15.78%)	12(15.78%)
Slit like	**3**(5.26%)	3 (7.89%)	6(6.57%)

Discussion

Foramen ovale (FO) is one of the important foramina used for various invasive surgical as well as diagnostic procedures. Knowing the anatomic variations of foramen ovale is important because surgical treatment of trigeminal neuralgia is most commonly accomplished by microvascular decompression by percutaneous trigeminal rhizotomy done through FO [6]. In a study conducted in India, forty patients of trigeminal neuralgia were treated with percutaneous trigeminal ganglion balloon compression. In all patients except one, the needle could be introduced easily. The only exception was the patient with foramen ovale stenosis, in whom, the needle just fitted in the foramen. The accuracy of percutaneous biopsy of cavernous sinus tumours through the foramen ovale is 84% [7] and it is important before making any decision to indicate open surgical, radiosurgical or radiotherapeutic treatment. Nasopharyngeal carcinoma (NPC) frequently spreads intracranially and most common route of spread is through the foramen ovale (34%) [8]. The CT-guided transfacial fine needle aspiration technique through FO to diagnose squamous cell carcinoma, meningioma, Meckel cave's lesions allows biopsy of deep lesions that would otherwise require open surgical biopsy or craniotomy. This results in decreased patient morbidity and significant cost reduction. Electroencephalographic analysis of seizure by electrode placed at FO is done. FO electrode technique provided good neurophysiological information in candidates for selective amygdalohippocampectomy. So knowledge of the exact topography and morphometry of the FO electrodes is required for a more precise anatomo-electro-clinical correlation of seizures [9].

In the present study mean length of FO was 9mm on right side and 9.5mm on left side. On comparing length of foramen ovale on right and left side the later was found to be longer than the former but the difference between the two was statistically insignificant (p>0.01).

In a study conducted by N.Gupta an average mean length of foramen ovale was 7 mm on right side and average length was 7.46 mm on left side and difference between right and left side was observed which is similar to present study [10]. In a developmental study conducted in Japan by Yanagi, 1987, an average maximal length of foramen ovale was 7.48 mm and average minimal length was 4.17 mm and significant difference between right and left side was not observed which is similar to present study [11]. Fluoroscopically-assisted laser targeting of the FO conducted in New York by Landl MK, 2005, showed length 6.9mm on right side and 6.8 mm on left side with range length 5.0-10.0mm; left, 6.0-9.0mm; right [12].

According to present study mean width on right side was 3.18 mm and 3.21mm on left side. Maximum width was 5.0 mm on both right and left sides. Minimum width on right side was 2 mm and 2.5 mm on left side. Difference between the width of right and left side was statistically not significant ($p > 0.01$).

In a study conducted by N.Gupta maximum width of foramen ovale was 5.0mm on both right and left sides while minimum width was 1.0mm on right side and 2.2mm on left side. Mean width on right side was 3.21+\-1.02mm and 3.29+/-0.85mm on left side. Difference between the width of right and left side was statistically not significant ($p > 0.01$) [10]. Similar findings were observed by a German study where average width was 3.7mm in adult skull [13]. Average width on right side was 3.4mm and 3.8mm on left side was reported in a study conducted by fluoroscopically- assisted laser targeting of foramen ovale in New York [14]. Arun Kumar found in his study that maximum length of foramen ovale was 9.8 mm and minimum length was 2.9 mm. Mean length on left side was 6.56 mm,on the right side was 5.08 mm; Mean width on left side was 3.60 mm and on the right side 3.64 mm [15].

In our study the shape of foramen ovale was oval in 47.36%; almond in 28.94%; round in 15.78% and slit like in 6.57% of skulls. Biswabina Ray [10] et al, reported that maximum number of foramen to be oval shaped 61.4% almond shaped 34.3%, round shaped 2.9% and slit like 2.9%. The similar results were observed in developmental studies conducted by Yanagi [11].

Roma Patel [16] et al mentioned variations in the shape of foramen ovale as oval 59.5%, round 27.5%, almond 12% and slit like 1%. A thorough understanding of fetal growth and development is the key to understanding both the completed normal anatomic structure and the abnormal variations. Most of the central skull base develops from endochondral ossification through an intermediary chondrocranium. The sphenoid bone consists of the body (formed by the presphenoid and postsphenoid centres, with a contribution from the medial crus of the orbitosphenoid). The lesser and greater wings from orbitosphenoids, alisphenoids respectively [17]. The ossification of the skull progresses in an orderly pattern from posterior to anterior. The postsphenoid (14 weeks) and then presphenoids (17 weeks) of the sphenoid bone ossify. Ossification is seen laterally in the orbitosphenoid (16 weeks) and the

alisphenoids (15 weeks). A CT scan study of fetal specimen with a gestational age of 22weeks 3 days showed ossification of alisphenoid (that forms greater wings) and FO seen as large defect. Ossification around the large trunk of mandibular nerve takes place later. Hence the variations observed in shapes and margins of FO indicate bony outgrowth during developmental process. FO is of great surgical and diagnostic importance. Knowledge of the variations of its anatomy may help to better identify and preserve important neurovascular structures during approaches to the middle cranial fossa because surgical treatment of TN is most commonly done by microvascular decompression by percutaneous trigeminal rhizotomy done through FO [17,18]. In a study conducted in china, 100% success rate was achieved when FO was punctured in TN radiofrequency ablation under the guidance of X-ray real time imaging [19]. Moreover electroencephalographic analysis of seizure by electrode placed at FO provided good neurophysiological information in candidates for selective amygdalo-hippocampectomy [09]. Nasopharyngeal carcinoma frequently spreads intracranially via FO (34%) [08]. The CT guided fine needle aspiration technique through FO permits biopsy of deep lesions that otherwise require open surgical biopsy or craniotomy, thus decreasing cost and patient morbidity [20,21].

Conclusion

In the present study, the mean length of FO was 7.27 ± 1.184 mm on right side and 7.46 ± 1.13 mm on left side. Whereas the observed maximum and minimum length was 9.0 mm and 3.0 mm on right side while 9.5 mm and 4 mm on left side. However, the difference between the length of right and left side, was statistically not significant. The Maximum width of FO was 5 mm on both sides, while the minimum width of right and left side was 2.0 mm and 2.5 respectively , (Table 1), and the mean width on right side was 3.18 ± 0.62 mm and 3.244 ± 0.75 mm on left side statistically insignificant difference between the two sides. The various shapes of foramen ovale observed were typically oval in 36 (19 right & 17 left), almond in 22 (10 right & 12 left), round in 12 (6 right & 6 left) and slit like in 6 skulls (3 right & 3 left) (Table 2).

This study is of clinical, diagnostic and anatomical significance to medical practitioners in cases of trigeminal neuralgia, detection of tumours, bony outgrowth that may lead to ischaemia, necrosis and possible paralysis of the parts of the body being supplied, drained or innervated by its contents. And it is of paramount importance in diagnosing any aneurysm or vascular lesions of the cranial cavity. This knowledge will be useful to neurosurgeons for the identification and preservation of the neurovascular structures when using approaches to the middle cranial fossa. Also it is of important for Anatomists & Anthropologists.

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Anatomical Study of the Osteo Meatal Complex of the Middle Meatus

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Abstract

Introduction: Middle turbinate is an important landmark of lateral nasal wall during endoscopy. The aim of this study was to examine the surgical anatomy of middle turbinate in hemisected heads which allows better visualization of the middle turbinate and middle meatus and to provide anatomical knowledge to the surgeons performing Endoscopic Sinus Surgeries (ESS) and middle turbinectomies. *Method:* The openings of paranasal sinuses in middle meatus were studied in 100 hemisected adult Indian cadaveric heads. *Results:* The mean angles between the lowermost portion of limen nasi and openings of frontal sinus i.e. *f'*, middle ethmoidal cells i.e. *m'*, maxillary sinus i.e. *s'* were 64.8°, 46.71°, 38.59° respectively. The mean distance between the lowermost portion of limen nasi and openings of frontal sinus i.e. *f*, middleethmoidal cells i.e. *m*, maxillary sinus i.e.*s*.are 41.07 ± 4.86 mm, 43.56 ± 3.8 mm, 36.84 ± 3.96 mm.The difference observed in the readings for the two sides is not statistically significant.

Three percent cases showed two middle ethmoidal cell openings.Fivepercentcases showed dual maxillary sinus openings.Fourpercent cases showed absence of maxillary sinus openings.

Keywords: Endoscopic; Surgeons; Middle; Osteomeatal; Complex.

Introduction

A Chinese fortune teller regards the nose as a hill of the face generating will power and representing intellectual capabilities. And especially in the present scenario with the advanced modalities of treatment, nasal anatomy with respect to nasal conchae has become very significant for the otorhinologists while performing Endoscopic Sinus Surgery (ESS).

A series of air filled expansions, the paranasal sinuses, lie within either the lateral walls of the nasal cavities or in communication with them in adjacent bones.The nasal apparatus serves to warm, humidify, and to some extent filter, particles from the inhaled air.

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The middle turbinate is an important landmark of lateral nasal wall during endoscopy[1]. Middle turbinate, also called middle concha, is a medial process of the ethmoidal labyrinth.The area under the middle turbinate into which the maxillary sinus, the frontal sinus and anterior ethmoidal and middle ethmoidal systems open is termed the osteomeatal complex. It is located above inferior turbinate. Anterior ethmoid – middle meatal area is an important site for early involvement in most inflammatory sinuses diseases [2].

The middle meatus presents the ethmoidal bulla produced by the bulging of the middle ethmoidal air cells, which open on or above the bulla. Anterior to the bulla is a curved two dimensional slit, the hiatus semilunaris, which leads into the ethmoidal infundibulum. It is continuous with the frontonasal recess into which the frontal nasal sinus often opens. The anterior ethmoidal cells open into the infundibulum or the frontonasal recess[2]. The maxillary sinus ostium is usually present on the lateral aspect of the infundibulum between its middle and posterior third; and accessory ostium may be present anterior or posterior to the lower part of the uncinate process[2].

Since ESS proceeds in an anterior to posterior direction.The variations in osteomeatal complex are paradoxical curvatureand hypertrophy of middle turbinate, pneumatized middle turbinate, uncinate hyperplasia, deviation of uncinate process,concha bullosa, large ethmoidal bulla, large agger nasi,septal deviation, Onodi cell and Haller cell. These variations may be one of the causes of chronic sinusitis [3].

So this present study was designed to examine the anatomy of middle meatus in fully exposed hemisected nasal cavities. The aim was at finding such variations in the the osteomeatal complex, which may have clinical implications and thus provide guidelines to ENT surgeons, especially in Indian populations.

Aims

The aim was to study the openings of paranasal sinuses in middle meatus.Objectives wereto study openings of paranasal sinuses in middle meatus in detailed manner:

1. To study the mean angles between the lowermost portion of limen nasi and openings of frontal sinus i.e. *f'*, middle ethmoidal cells i.e. *m'*, maxillary sinus.i.e..*s'*.
2. To study the mean distance between the lowermost portion of limen nasi and openings of frontal sinus i.e. *f*, middle ethmoidal cells i.e. *m*, maxillary sinus i.e.*s*.
3. Comparison between the left and right side readings of the above mentioned parameters.
4. To provide Indian data for above mentioned parameters.
5. To note any variations while studying these parameters.

Methods

One Hundred hemisected adult Indian cadaveric heads were used in this study. These were obtained from the cadavers used for gross anatomical dissections by different medical and dental colleges. Due permission was obtained from the concerned authorities of these medical colleges, prior to beginning the study. Consent was not required being a cadaveric study.

Fifty two of these hemisected adult cadaveric heads involved the right side and forty eight involved the left side. Their ages ranged from 25 years to 75 years. Eight six specimens were obtained from male cadavers and fourteen were from females. No specimen showed evidence of prior nasal surgery or gross pathology of their middle turbinates.

Wherever available the 'body cutting machine' was used to obtain the hemisections. At other places, a saw was used for the same. Wherever present the nasal septum was cut with the help of long scissors, scalpel and toothed forceps, so as to view the lateral nasal wall directly. Any secretions, dust etc. was cleared off from the surface and underneath the superior turbinate, middle turbinate and Inferior turbinate. This made the area of study clearly visible.

1. Hemisected heads of Indian cadavers were obtained.
2. Of these the cadavers without evidence of prior nasal surgery or gross pathology of their middle turbinates were selected.
3. The measurements were taken from the lowermost portion of limen nasi, the anterior most landmark when inserting the endoscope and other surgical instruments.
4. Vernier Caliper and a protractor were used for measurements. The protractor was leveled with the help of 'acrylic cutting machine'.
5. The openings of the paranasal air sinuses in middle meatus were studied as illustrated in schematic figures 1 to 3 and figures 1-2. For studying these openings the middle turbinate was reflected upwards detaching it slightly from its anterior end. The angles and distances were measured from the lowermost portion of the limen nasi. Careful measurements were done and recorded. The range for each parameter and their means were recorded.

Results

In the present study, the angles and the distances of the apertures of sinuses opening into the middle meatus have been studied from the standard point i.e. the lowermost portion of the limen nasi.

Angles

Note:

- Only 97 readings for the ethmoidal cells are considered as three specimens showed two openings for the middle ethmoidal cells.
- Similarly, for the maxillary sinus of the 100 readings, 9 readings showed variations as four specimens showed complete absence of maxillary sinus openings, and rest five showed

dual openings for the maxillary sinus.

1. The mean angle between the lowermost portion of limen nasi and opening of frontal sinus i.e. *f'* is 64.8° (range: 47°- 72°). Frequency distribution chart for these readings has been prepared as seen in Figure 3.
2. The mean angle between the lowermost portion of limen nasi and opening of middle ethmoidal cells i.e. *m'* is 46.71° (range: 33°- 62°).
3. The mean angle between the lowermost portion of limen nasi and opening of maxillary sinus i.e. *s'* is 38.59° (range: 20°- 66°). The SD is 8.24° for *s'*. This larger value indicates that the range is wide when compared to the other angles.
4. Table 1 shows the mean, mode, median etc. values for *f'*, *m'*, *s'*.
5. The mean, mode and median are approximately close and so the readings are normally distributed for all the three angles.

Also, comparison between the left and right side readings were done for these parameters (Table 2).

1. The mean value of *f'* for left side is 65.40° and for right side is 64.25°.
2. The mean value of *m'* for left side is 46.90° and for right side is 46.53°.
3. The mean value of *s'* for left side is 38.89° and for right side is 38.30°.

In general, the left side readings were found to be greater than the right side. However, these are not statistically significant.

Distances

(Table 3 shows the mean, mode, median etc. values for *f*, *m*, *s*.)

1. The mean distance between the lowermost portion of limen nasi and opening of frontal sinus i.e. *f* is 41.07 ± 4.86 mm (range: 31.48 to 50.0 mm). Frequency distribution chart for these readings has been prepared as seen in Figure 4.
2. The mean distance between the lowermost portion of limen nasi and opening of middle ethmoidal cells i.e. *m* is 43.56 ± 3.8 mm (range: 35.82 to 54.14 mm).
3. The mean distance between the lowermost portion of limen nasi and opening of maxillary sinus i.e. *s* is 36.84 ± 3.96 mm (range: 26.08 to 46.68 mm).

Also, comparison between the left and right side readings were done for these parameters.

1. The mean value of *f* for left side is 41.15 mm and for right side is 41mm.
2. The mean value of *m* for left side is 43.35 mm and for right side is 43.76mm.
3. The mean value of *s* for left side is 36.21 mm and for right side is 37.47mm.

It is observed from the table above that for *f* the overall mean readings on the left side are higher as compared to right side. They are however statistically not significant.

Similarly, it is observed from the table above that for *m*&*s* the overall mean readings on the right side are higher as compared to left side. They are however statistically not significant.

Variations

1. While deriving the results of the measurements related to the apertures of middle ethmoidal air cells, three readings out of hundred were excluded where dual middle ethmoidal openings were found. Thus 3% cases showed more than one middle ethmoidal opening on the bulla ehtmoidalis as seen in figure 5. (Table 5 shows the readings in three specimens with two openings for the middle ethmoidal cells.) Thus it is important for the endoscopist to remember that more than one middle ethmoidal opening at varied angles and distances can be present. This is also confirmed in other literatures [2].

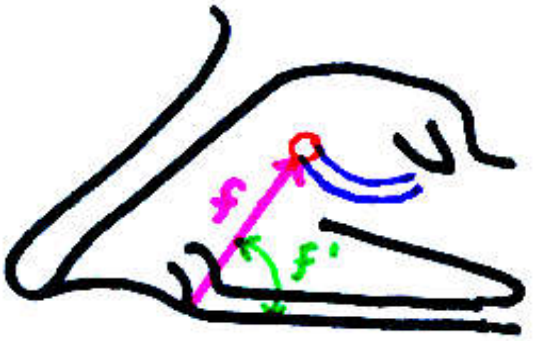
   This could be normal and sometimes pathological, in cases of chronic sinusitis where a normal ostium is blocked and a new ostium is naturally created for drainage of air cells.
2. Figure 6 also shows middle ethmoidal ostium on undersurface of bulla ethmoidalis, opening in hiatus semilunaris. This is against the usual description of these ostia being present on the bulla ethmoidalis. In this case the ethmoidal bulla is minimally pneumatized.
3. Similarly, while studying the maxillary sinus apertures it was found that four specimens did not show any maxillary sinus openings, inspite of all attempts to find any such opening in the hiatus semilunaris and beneath it. This definitely is not a normal finding. Interestingly, apertures were bilaterally absent in one cadaver. Pathologically these apertures could be blocked because of thick adherent secretions or presence of mucocoeles/polyps.
4. Rest five cases showed dual maxillary sinus openings. It was bilaterally present in one

cadever and unilaterally in three cadavers.

It was observed that, of these two opening one was usually large (more than 5 mm in diameter) and other small (less than 4 mm diameter). These were present at varied angles and distances from the standard point i.e. lowermost portion of limen nasi. However, in two cases the openings were almost of similar diameter. Such cases of accessory maxillary ostia have been described earlier[2](Table 6 shows the readings in five specimens with dual openings for the maxillary sinus)

5) In cases with large maxillary sinus openings, these were found to be > 5 mm or 5 – 8 mm were observed, usually underneath hiatus semilunaris and placed anteriorly (Figure 6).

Openings of the Paranasal Sinuses in Middle Meatus

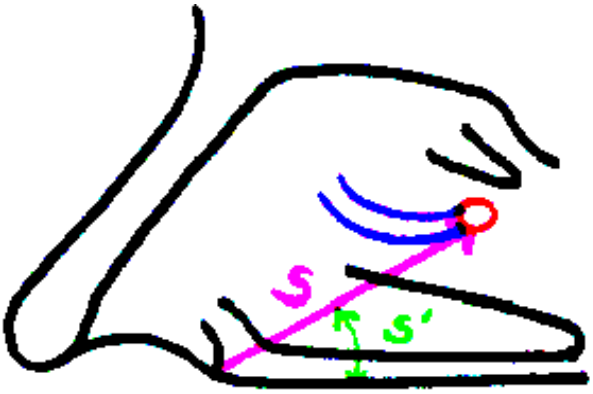


Schematic Fig. 1: Measurement of *f, f'*

1. *f* = distance between lowermost portion of limen nasi and opening of frontal sinus.
2. *f'* = angle between lowermost portion of limen nasi and opening of frontal sinus.

Schematic Fig. 2: Measurement of *m, m'*

1. *m* = distance between lowermost portion of limen nasi and opening of middle ethmoidal cells.
2. *m'* = angle between lowermost portion of limen nasi and opening of middle ethmoidal cells



Schematic Fig. 3: Measurement of *s, s'*

1. *s* = distance between lowermost portion of limen nasi and opening of maxillary sinus.
2. *s'* = *angle* between lowermost portion of limen nasi and opening of maxillary sinus.

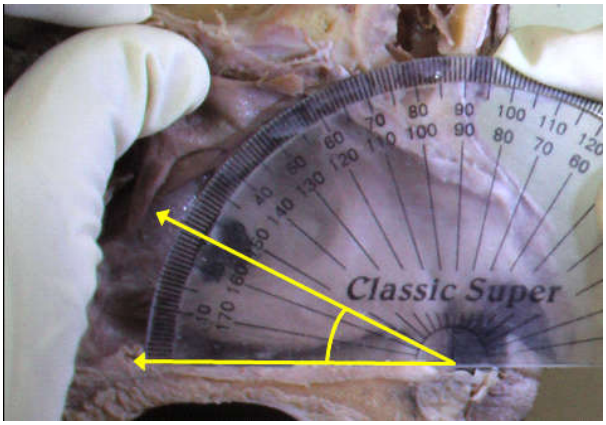


Fig. 1: Measurement of *s'*
(*s'* = Angle between lowermost portion of limen nasi and opening of maxillary sinus.)

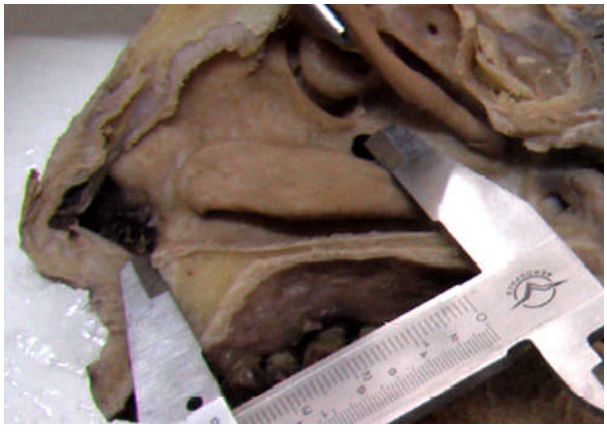


Fig. 2: Measurement of *s*.
(*s* = Distance between lowermost portion of limen nasi and opening of maxillary sinus.)

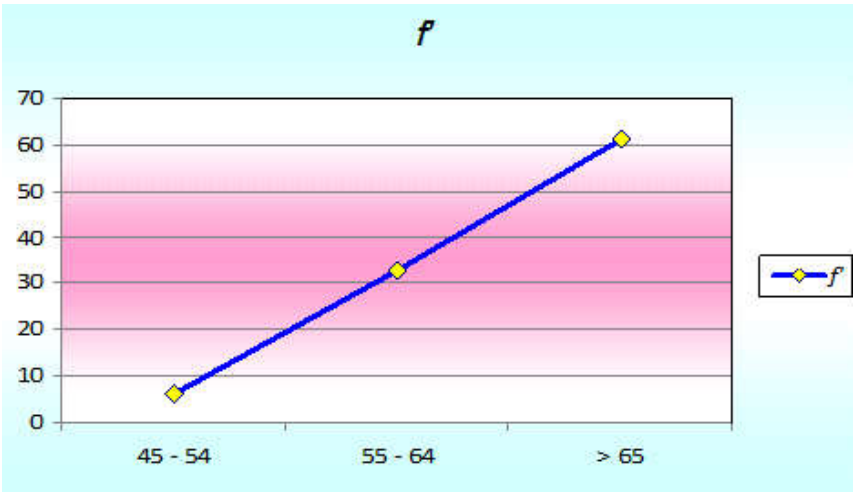


Fig. 3: Frequency distribution chart for *f'*
Along X axis is *f'* (in degree), Y axis indicates percentage distribution.
f' = Angle between lowermost portion of limen nasi and opening of frontal sinus.

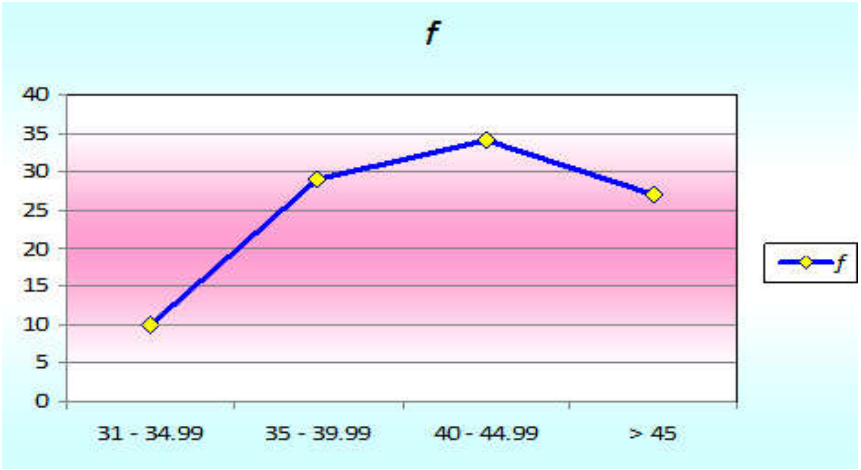


Fig. 4: Frequency distribution chart for *f*
Along X axis is *f* (in mm), Y axis indicates percentage distribution
f = Distance between lowermost portion of limen nasi & opening of frontal sinus.

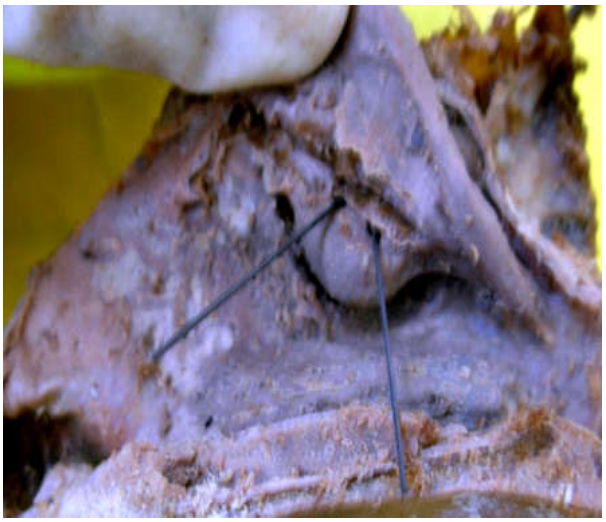


Fig. 5: Two middle ethmoidal sinus openings

Fig. 6: Large maxillary sinus opening, middle ethmoidal sinus opening beneath bull ethmoidalis

Table 1: Mean, mode, median etc. values for *f′, m′, s′*

Angles	*f*'(in degree)	*m*'(in degree)	*s*'(in degree)
Mean	64.8	46.71	38.59
Standard Error	0.56	0.56	0.86
Median	65	45	38
Mode	68	45	38
Standard Deviation	5.58	5.52	8.24
Minimum	47	33	20
Maximum	72	62	66
Count	100	97	91

The mean, mode and median are approximately close and so the readings are normally distributed for all the three angles

Table 2: Comparison of the angles on left and right side for *f′, m′, s′*

	Angle *f*' (in degree)		Angle *m*' (in degree)		Angle *s*' (in degree)	
	Left	Right	Left	Right	Left	Right
Mean	65.40	64.25	46.90	46.53	38.89	38.30
Variance	26.12	35.68	34.18	27.50	67.65	69.59
Observations	48	52	48	49	45	46
Df	98		95		89	
t Stat	1.03		0.32		0.34	
P value	0.31		0.75		0.74	

f′ = Angle between lowermost portion of limen nasi & opening of frontal sinus.
m′ = Angle between lowermost portion of limen nasi & opening of middle ethmoidal cells.
s′ = Angle between lowermost portion of limen nasi & opening of maxillary sinus.
df = Degree of freedom

Table 3: Mean, mode, median etc. values for *f, m, s*

Distances	*f* (mm)	*m* (mm)	*s* (mm)
Mean	41.07	43.56	36.84
Standard Error	0.49	0.39	0.42
Median	41.17	43.38	36.82
Mode	32.06	42.32	38.34
Standard Deviation	4.86	3.80	3.96
Minimum	31.48	35.82	26.08
Maximum	50	54.14	46.68
Count	100	97	91

Note:
1. Only 97 readings for the ethmoidal cells are considered as three specimens showed two openings for the middle ethmoidal cells.?
2. Similarly, for the maxillary sinus of the 100 readings, 9 readings showed variations as four specimens showed complete absence of maxillary sinus openings, and rest five showed dual openings for the maxillary sinus

Table 4: Comparison of the distances on left and right sides for *f, m, s*

	Distance f (mm)		*Distance m (mm)*		*Distance s (mm)*	
	Left	Right	Left	Right	Left	Right
Mean	41.15	41.00	43.35	43.76	36.21	37.47
Variance	22.32	25.19	13.08	15.93	12.27	18.56
Observations	48	52	48	49	45	46
Df	98		95		89	
t Stat	0.16		-0.53		-1.53	
P value	0.88		0.60		0.13	

f = Distance between lowermost portion of limen nasi & opening of frontal sinus.
m = Distance between lowermost portion of limen nasi & opening of middle ethmoidal cells.
s = Distance between lowermost portion of limen nasi & opening of maxillary sinus.
df = Degree of freedom

Table 5: Readings in three specimens with two openings for the middle ethmoidal cells

Sr.No	*m*' 1(*in degree*)	*m*′2(*in degree*)	*m*1 (*mm*)	*m*2 (*mm*)
1	38	42	47.61	48.24
2	47	44	40.04	40.08
3	45	36	40.02	41.32

Table 6: Readings in five specimens with dual openings for the maxillary sinus

Sr. No	*s'* 1 (degree)	*s'*2 (degree)	*s*1 *(mm)*	*s*2 *(mm)*
1	45	32	33.24	42.64
2	40	40	34.08	38.12
3	30	40	38.84	32.78
4	40	18	40.12	31.16
5	40	25	31.24	37.26

Discussion

Development of Paranasal Sinuses [4]

Some paranasal sinuses begin to develop during the late fetal life, such as the maxillary sinuses; the reminder of them, develop after birth. They form from outgrowths or diverticula of the walls of the nasal cavities and become pneumatic (air filled) extensions of the nasal cavities in the adjacent bones, such as the maxillary sinuses in the maxillae and the frontal sinuses in the frontal bones. The original openings of the diverticula persist as the orifices of the adult sinuses.

Postnatal Development of the Paranasal Sinuses [4]

Most of the paranasal sinuses are rudimentary or absent in the newborn infants. The maxillary sinuses are small at birth (3-4 mm in diameter). These sinuses grow slowly until puberty and are not fully developed until all the permanent teeth have erupted in early adulthood [4].

No frontal or sphenoidal sinuses are present at birth. The ethmoidal cells are small before the age of two years and they do not begin to grow rapidly until six to eight years of age. Around the age of two years, the two most anterior ethmoidal cells grow into the frontal bone, forming a frontal sinus on each side [4].

Usually the frontal sinuses are visible in the radiographs by the seventh year. The two most posterior cells grow into the sphenoid bone at about the age of two years, forming two sphenoidal sinuses. Growth of the paranasal sinuses is important in altering the size and shape of face during infancy and childhood, and in adding resonance to voice during adolescence [4].

In 1929 Mosher wrote, "If (the ethmoid) were placed in any other part of the body it would be an insignificant and harmless collection of bony cells. In the place where nature has put it, it has major relationships as that diseases and surgery of the labyrinth often lead to tragedy. Any surgery in this region should be simple but it has proven one of the easiest ways to kill a patient" [5].

Van Alyea advocating conservative surgery of the sinuses in 1951 wrote, "The early rhinologists were not concerned about the preservation of functioning structures"[6].

Then during the period of rigid intranasal endoscopy, the nasal endsoscopists were described as "Nasal Astronomers.", for proposing new ideas and new techniques to a community accustomed to headlight and open surgical techniques [7].

In 1978 the first systematic and detailed work documenting endoscopic findings was published in English by Messerklinger.

Messerklinger noted that the interruption of normal mucociliary clearance the middle meatus and ethmoid air cell system causes both persistence of local inflammation and affected the drainage of the frontal and maxillary sinuses, leading to the potential for recurrent infection [8]. Thus the importance of the middle meatus – anterior ethmoid complex in thepathogenesis of frontal and maxillary sinus disease led Naumann [9] to describe the area as the osteomeatal unit. Also in recognition of the importance of this area for the maxillary sinus, Prott [10] termed the maxillary ostium canalis maxillo–ethmoideo-nasalis. There is therefore increasing recognition of the impact of this area in inflammatory disease of the major sinuses.

The area of the anterior ethmoid is poorly visualized on routine sinus roentgenograms where only gross opacification is usually evident. Similarly anterior rhinoscopy reveals little information with regard to middle meatal cleft and no information regarding the infundibular opening and maxillary sinus orifice. Computed tomography is used to reveal mucosal changes deeper in the osteomeatal complex that are not visible endoscopically and to identify the extent of disease. The diagnostic evaluation for functional endoscopic sinus surgery (FESS) therefore consists of a combination of systematic nasal endoscopy and CT, the two modalities being adjunctive [8].

Thus the detailed position of these apertures (of the paranasal sinuses) and the precise form and the sizes vary enormously between the individuals. Since there is absence of similar previous studies ; we hope that this study sets standard for similar studies to be conducted in different regions , which may provide data regarding similarities or ethinic differences.

Conclusion

1. The mean angles between the lowermost portion of limen nasi and openings of frontal sinus i.e. *f'*,

middle ethmoidal cells i.e. *m'*, maxillary sinus i.e. *s'* were 64.8°, 46.71°, 38.59° respectively.

2. The mean distance between the lowermost portion of limen nasi and openings of frontal sinus i.e. *f*, middle ethmoidal cells i.e. *m*, maxillary sinus i.e.*s*.are 41.07 ± 4.86 mm, 43.56 ± 3.8 mm, 36.84 ± 3.96 mm.The difference observed in the readings for the two sides is not statistically significant.
3. Three percent cases showed two middle ethmoidal cell openings. Fivepercent cases showed dual maxillary sinus openings. Fourpercent cases showed absence of maxillary sinus openings.
4. From the above findings it can be concluded that the detailed position of the apertures in the middle meatus vary enormously between individuals.

In conclusion this study documents the anatomical variation of the middle turbinate and osteomeatal complex, an important landmark of lateral nasal wall during endoscopy and partial turbinectomies. The documentation of these variations and their frequencies would be useful for the otorhinologists while performing endoscopy and be ready with optional interventions as and when required.

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Original Article

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Item Analysis (Postvalidation) of MCQs in Anatomy for the First MBBS Course

Prashant E. Natekar*, Fatima De Souza**

Abstract

Objectives: MCQs is the most commonly used method for assessing the performance of medical students. The aim of this study is to assess the quality of MCQs for creating viable question bank for future use, to identify the low achievers and their learning difficulties, faculty development and also for its use in high stake examination. *Methodology:* 150 students of First year MBBS course attended 20 MCQs in the subject of Anatomy Goa Medical College Bambolim Goa. The MCQs were best single response type with four options, each item comprising of one mark to be answered in fifty seconds for 20 marks. There was no negative marking and 50% score was considered as pass. Prevalidation of MCQs was done by senior faculties. Post validation of the MCQs was done by Item analysis for Difficulty Index, Discrimination Index and Distractor Effectiveness. *Results:* The items analyzed had Difficulty Index (p) were acceptable (50%), too easy (10%) and too difficult (10%). The Discrimination Index (d) were good (50%), excellent (30%) and acceptable (20%). Since all the items had response more than 5% and were functional distractors, the Distractor effectiveness was zero. *Conclusion:* Item analysis can tell us if an item was too easy or too difficult and how it can be discriminated between high and low achievers and also all the distractors were effective.

Keywords: MCQs; Item Analysis; Difficulty Index; Discrimination Index; Distractor Effectiveness.

Introduction

The educational spiral consists of teaching learning and evaluation. Hence by evaluation of the MCQs we can assess the quality of the items and its impact in summative, formative and also in High stake examinations.

MCQS emphasize the recall of factual information rather than conceptual understanding and interpretation of concepts [1].

Properly constructed MCQs can assess higher cognitive processing Blooms taxonomy such as interpretation, synthesis and application of knowledge instead of just testing recall of isolated facts [2,3]. The most characteristics of the evaluation process and evaluation tool are relevance, validity reliability, objectivity and feasibility [4].

MCQs comprises of only 10 percent of marks of total written examination in preclinical subjects. The post exam analysis is currently taken into consideration for the formative and summative examinations in Anatomy, Physiology and Biochemistry at Goa Medical College Goa.

MCQs are not included in Paramedical and Clinical subjects.

However the entire examination for admission to All India Postgraduate courses and DNB courses in the field of Medicine and Post graduate courses in Dentistry is by the marks scored in High Stake examination evaluated by MCQs.

Objectives

1. To assess the quality of MCQs for creating viable question bank for future use.
2. To identify the low achievers and their learning difficulties
3. Faculty development

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4. Use in High stake examination

Methodology

Study Design: Cross Sectional

150 students of First year MBBS course attended 20MCQs in the subject of Anatomy during their preliminary examination at Goa Medical College Bambolim Goa. The MCQs were best single response type with four options, each item comprising of one mark to be answered in fifty seconds for 20 marks. There was no negative marking and 50% score was considered as pass. There was no negative marking. A group of senior faculty members were involved in prevalidation of MCQs. Post validation of the MCQs was done by Item analysis. The correct answer was referred as "Key"[5].

The papers were evaluated and students were ranked in the order of merit. These papers were arranged in descending order according to their scores. The top one third were labeled as High Achievers Group (HAG) and the lower one third were labelled as Low Achievers Group (LAG). The middle third were not considered for the study.

*Prepare a table for each item as follows: Correct Key. **C***

Options	No. of students selecting option amongst HAG (H)	No. of students selecting option amongst LAG (L)	Total Response N%
A			
B			
C			
D			
Not attempted			
Total	**50**	**50**	**100**

Evaluation

Post validation for each item will be analyzed for

❖ *Difficulty Index (P)*

Percentage of students who selected the correct response. Whether the item had appropriate level of difficulty

P = H + L/N x 100

H = Number of students in HAG answered correctly

L = Number of students in LAG answered correctly

N = Total number of students

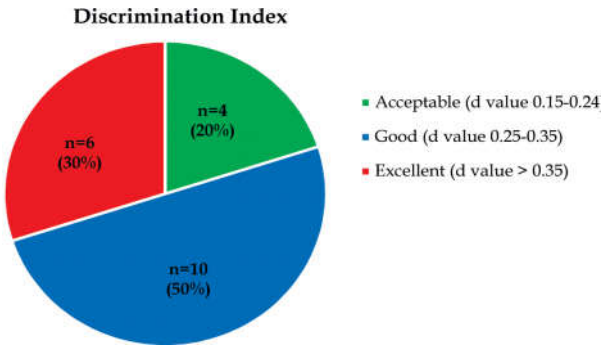
Interpretation of Difficulty Index (P): P value

< 30	30	40	50	60	70	> 70
Too Difficult			Good Acceptable			Too easy Reject

❖ *Discrimination Index (d)*

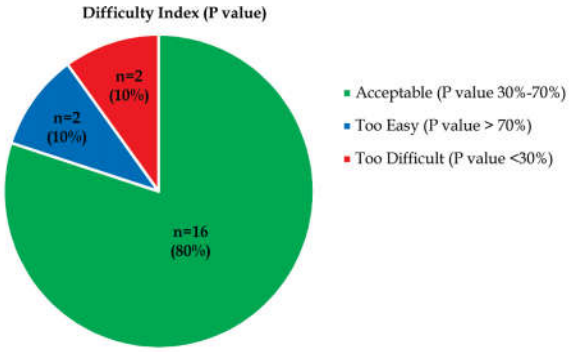
Whether the item is capable of discriminating between knowledgeable and ill-informed students

d = H – L/N x 2



Interpretation of Discrimination Index (d): d value

< 0.15	0.15-0.24	0.25-0.34	> 0.35
Discard	Acceptable	Good	Excellent



❖ *Distractor Effectiveness*

Effectiveness of the option.

Any distractor attracting less than 5% of the total response is said to be non-functional. It is useful to get feedback on effectiveness/functionality of each alternative, since poor alternatives would lead to greater possibility of guessing the correct answer [6].

Feedback from Staff

Faculty development for MCQs and Item analysis

To test cognitive domain

Can be administered in a short period

Can be assessed by computer

To detect the technical flaws in item

To provide feedback to students

To provide feedback to teachers

Aids in selection of valid MCQs

Tedious

Time consuming

Hard work

Cooperative efforts

Feedback from Students

1. Chances of Guess work
2. Tests the knowledge accurately
3. Easy/ too difficult
4. Gets confused with the other options

Results

In our present study 20 items were analyzed after prevalidation of the MCQS for difficulty index, discrimination index and for distractor effectiveness.

The mean score of the difficulty index (p value) showed 80 percent of the items were within the acceptable limits (P value 30% to 70%), 10 percent were too easy (P value >70%) and 10 percent were too difficult (P value< 30%), as shown in pie diagram 1.

The mean score of discrimination index (d value) showed that 50 percent of the items were good (d value 0.25-0.35), 30 percent were excellent (d value >0.35) and 20 percent were acceptable (d value 0.15 – 0.24) as shown in pie diagram 2.

Discussion

The assessment (summative and formative) forms an important component of evaluation in teaching learning process in addition to long assay and short assay questions. MCQs helps in assessing the students wherein the syllabus is very vast so as to rank them in high stake examination. Prevalidation of properly constructed MCQs is very tedious, time consuming, cooperative efforts not only to test the standard or quality but also levels of knowledge. The good quality of MCQs can only be possible if they are subjected to item analysis.

In various studies conducted on item analysis it has been reported that the difficulty index is 61% were in acceptable range (p 30-70%), 24% (p>70%) as too easy and 15% items were too difficult (p<30%) [7]. Studies also reported that difficulty index showing 62% items in acceptable range (p30-70%), 23% were too easy (p>70%) and 15% were too difficult (p<30%) [8].

Other studies revealed that difficulty index showed 80% of items were in acceptable range (p 30-70%) and 20% in unacceptable range (p>70% & p< 30%) whereas discrimination index (d) showed 40% items > 0.35, 42% between 0.2 -0.34 and 18% <0.20 [9]. Similarly the difficulty index of the 62% items was in acceptable range (p 30-70%), 32% (p>70%) too easy &6% too difficult (p<30%) whereas the discrimination index showed 52% items were >0.35, 18% between 0.2-0.34 and 30% items had <0.2 [10]. The negative discrimination which has been reported in 20% was probably due to wrong key, ambiguous framing of question or generalized poor preparation of the students.

In our present study the properly constructed and pre validated items the difficulty index (p) were 80% in acceptable range (p 30-70%), 10% were too easy (p>70%) and 10% were too difficult (p <30%). The discrimination index (d) in our present study reported 50% of the items were good d(0.25-0.34) & 30% were excellent d (>0.35) and 20% were in acceptable range d (0.15-.24).

A distractor is said to be functional only when it is attracted by at least 5% of the total response in the high achievers group and in the low achievers group. The non functional distractors is an indicator which provides us an opportunity to replace it by a functional distractor.

Earlier studies revealed that 52.2% were functional distractor (FD), 35.1% were nonfunctional distractors (NFD) and 10.2% were not chosen by any student [11]. Studies also revealed that 1.1 to 8.4% were FD and 38% were NFD[12], similarly 18.16% were FD and 35.33% NFD and 46.01% had nil response [10]. In our present study all were functional distractors (FD).

Conclusion

Item analysis can tell us if an item was too easy or too difficult and how it can be discriminated between high and low achievers and also all the distractors were effective.

Take Home Message

Helps in achieving better teaching, better learning and for high stake examination and also addition to the existing question bank.

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Transabdominal Sonographic Quantitative Analysis of the Fetal Cardiac Length in Third Trimester of Gestation

Sikandarbanu N. Yerolavi*, M. Natarajan**

Abstract

Antenatal ultrasonography is noninvasive and done on routine basis in our institution. A four chamber view of the fetal heart is done as a part of regular sonographic examination of the fetus. Most cases of congenital heart disease are of structural rather than functional origin. *Aims & objectives:* To determine cardiac length (major longitudinal diameter) of the fetal heart during the third trimester of pregnancy. To evaluate the relationship between fetal heart dimensions obtained from sonography (cardiac length) and Gestational age (weeks) Biparietal diameter (mm) Femur length (mm) & abdominal circumference. *Materials & Methods:* The fetal heart was studied with transabdominal sonography in 132 single normal pregnancies in third trimester Measurement of cardiac length (longitudinal diameter) of the heart was taken. Gestational age was assessed by fetal parameters that are biparietal diameter, femur length and abdominal circumference as per the norms in one of the Mumbai's medical teaching institute and tertiary care centre. *Results:* The linear increase of the fetal heart shows a strong and significant correlation with the increase of biparietal diameter, femur length and abdominal circumference. Relationships between the cardiac data and fetal age, biparietal diameter, femur length and abdominal circumference were explored by allometry and linear regression analysis in order to estimate cardiac growth rates during third trimester. *Conclusion:* This study verified that the heart grows very rapidly during the third trimester (positive allometry). This suggests that noninvasive analysis of cardiac data can be useful for the assessment of gestational age or for prenatal detection of congenital heart disease [1].

Keywords: USG; BPD; FL; AC; & CL.

Introduction

It has been proposed that a satisfactory four chamber view of the heart may be obtained in 95% of pregnancies after 18 weeks [2]. The importance of a normal four- chamber view has been emphasized by Copel et al., who showed that if this view on transabdominal ultrasonographic study was normal,> 90% of congenital heart anomalies could be ruled out [3].

Cardiac defect, the most common form of congenital defects, are found in 3 to 8 of every 1000 pregnancies. They account for 45 % of infant deaths from congenital defects, which is a far greater proportion than any other organ system [5].

The more severe the growth disturbance, the greater the disparity between the actual gestational age prediction by standard biometry, the size of the fetal heart is less affected by abnormalities in fetal growth than are other organ system [4].

Most cases of congenital heart disease are of structural rather than functional origin. Therefore distortion of the normal cardiac anatomy is an important finding on antenatal ultraasonographic evaluation [6].

If the diagnosis of congenital heart disease occurs prior to 23 weeks of gestation the patient has the option of termination of pregnancy. If a malformation is diagnosed in the third trimester, the fetus should be delivered at a facility equipped to care of the infant with congenital heart disease [7].

Therefore, it is important to recognize a possible abnormality on a four chamber view of the of the heart

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because it allows

1. Time for a second look at fetal echocardiography for a more precise diagnosis.
2. Prenatal counseling for parents.
3. Time for planned delivery.
4. Time for relocation of family to centers equipped to handle such cases.
5. Search time when heart transplantation is considered.
6. And eliminates delay in definite diagnosis and treatment[2]

Sonographic scan is noninvasive and safe modality for imaging fetal heart.

Since this procedure is done on routine basis in our institution I preferred to work upon it as my dissertation.

Aims and Objectives

Based on these facts and the ease as well as the availability of the resources guided the following aims and objectives for the study of dimension of fetal heart.

1. To determine cardiac length (major longitudinal diameter) of the fetal heart during the third trimester of pregnancy.
2. To verify that heart grows rapidly during the third trimester (positive allometry) and to note any congenital anomalies associated with them if present.
3. To evaluate the relationship between fetal heart dimensions obtained from sonography (cardiac length) and
   a. Gestational age (weeks)
   b. Biparietal diameter (mm)
   c. Femur length (mm)
   d. Abdominal circumference (mm)

Materials and Methods

A prospective study was conducted in one of the Mumbai's medical teaching institute and tertiary care centre. This study was done in collaboration with the Department of Radiology. Ethics committee permission was obtained prior to the commencement of the study.

One hundred and thirty two normal pregnant women in third trimester coming for routine antenatal ultrasonography were included in the study. Before doing sonography patients were informed about study and consent was taken after full satisfaction. The name and address of the pregnant women were documented as an identity mark. The obstetrics history and LMP (last menstrual period) was recorded. Gestational age was documented by LMP.

In the present study the cardiac 4-chamber view was studied by the traditional transabdominal scan because the heart is large enough in third trimester to be well examined with this technique.

The fetal heart was studied by transabdominal sonography to analyze the increase of cardiac length (major longitudinal diameter of the heart) during the third trimester. Relationships between the cardiac data and fetal age, femur length, biparietal diameter (BPD) and abdominal circumference (AC) were explored by allometry and linear regression analysis.

The third trimester was considered from 24 weeks to term. One hundred and thirty two single pregnancies without special medical problems were studied with transabdominal sonography covering four age groups viz.

a. 24-27.9 weeks (22 fetuses),
b. 28-31.9 weeks (50 fetuses),
c. 32- 35.9 weeks (50fetuses),
d. 36-40 weeks (10 fetuses).

The assessment of the gestational age considered by femur length, biparietal diameter and abdominal circumference as per the norms in one of the Mumbai's medical teaching institute and tertiary care center.

The femur is measured from the proximal to the distal end of the shaft the femoral head and distal epiphysis are not included in the measurement [19] (Fig. 1). As stated the rules for measurement of the femur are as follows, First align the transducer to the femur and freeze the plane that shows both the cartilaginous femoral head and distal condyle. Then place the measurement cursors at the junction of the cartilage and bone, being careful to avoid the distal femoral point [8].

The rules for measuring the BPD are as shown in Fig. 2. The rules of measurement of the fetal AC are as shown in Fig. 3. The length of the heart could be measured reproducibly in the 4-chamber view of the heart (Fig. 4).

Four Chamber View of the Normal Fetal Heart-

Normal orientation in the fetal chest-

Opposite of the spine → sternum.
Just posterior to sternum → right ventricle.
Just in front and left to the spine → descending aorta.
Just anterior to the descending aorta → left atrium [8].

The 4-chamber view with a detailed image of the heart was usually obtained with transabdominal scan in the third trimester an average time of 15 minutes was normally sufficient to perform the sonographic observation and to obtain a suitable image of the heart.

The length of the heart were recorded considering the major longitudinal length of the 4-chamber view of the heart (Fig. 5, 6). Cardiac length was measured between the sulcus terminalis immediate right of superior vena cava and the apex of heart. All the dimensions were taken in mm. After entire scanning the required images were saved on the machine. These were later transferred on a CD and a soft copy was made.

The data collection was completed within the stipulated time given by the Ethics committee. After having done with the final formalities, the data was compiled together. The total data of 132 pregnant women collected, was numbered serially as per the sequence of the collection and thus master chart was made. The data of pregnant women's were later grouped and statistically evaluated.

Relationships between the growth of the cardiac measurement and fetal parameters were explored by allometry and linear regression analysis in order to estimate cardiac growth rates during the third trimester.

The measurements of the heart (the dependent variable Y) were correlated with the fetal parameters (the independent variable X) after logarithmic transformation using the following model:

$$LnY = Ln\ a + (b)\ Ln\ X$$

R- Squared and F statistics were used to determine the significance of each regression and a t-test was used to determine the significance departure from a predicted slope at the alpha = 0.05 level. The validity of a linear model was examined with residual analysis. The use of log transformed data was important to overcome the situation of standardized residuals heterocedasticity due to increasing variability in Y with increasing values of X [9].

Because of the problem of biased estimates of slopes of Y on X when both variables are subject to measurement error, the slope of the principle axis of the standardized variables viz. reduced major axis (RMA, regression model II), was computed [9]. Each regression slope was checked for departure from isometry. A slope of 1 indicates isometry in the conditions of the present study [10].

Observations and Results

Correlation between Cardiac Length and Gestational age Correlations

		Ageusg	Cardialen
Ageusg	Pearson Correlation	1	.882(**)
	Sig. (2-tailed)		.000
	N	132	128
Cardialen	Pearson Correlation	.882(**)	1
	Sig. (2-tailed)	.000	
	N	128	128

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

Graph 1:

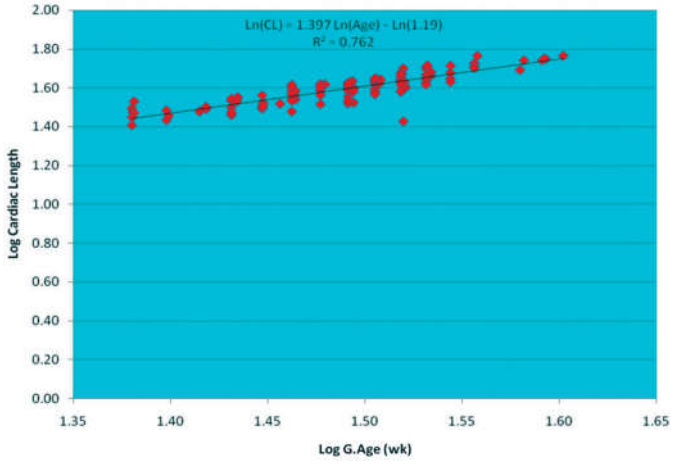


Table 1: Correlation between cardiac length and gestational age after regression analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.874(a)	.764	.762	.08718

a Predictors: (Constant), logage

ANOVA(b)

Model		Sum of Squares	DF	Mean Square	F	Sig.
1	Regression	3.104	1	3.104	408.421	.000(a)
	Residual	.958	126	.008		
	Total	4.061	127			

a Predictors: (Constant), logage
b Dependent Variable: logcarlen

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Upper bound	Lower boundr
1	(Constant)	-1.119	.237		-4.716	.000	-1.588	-.649
	logage	1.397	.069	.874	20.209	.000	1.260	1.534

a Dependent Variable: logcarlen

$$\text{Ln } Y = (b) \text{ Ln } X + a$$

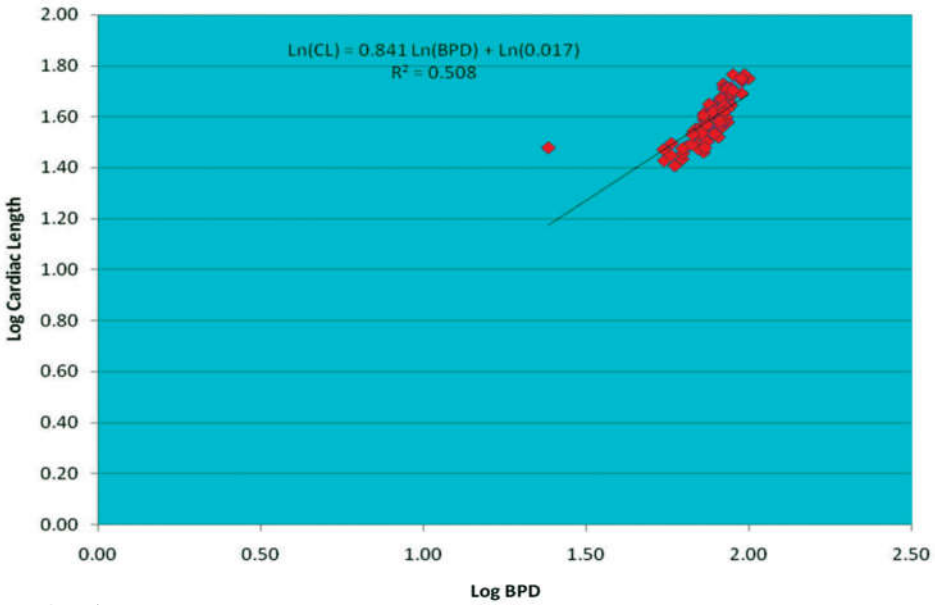
$$\text{Ln (CL)} = 0.874 \text{ Ln (GA)} - 1.119$$

Correlations between cardiac length and gestational age were assessed by using Pearson's correlation coefficient. It was found to be positively correlated, r = 0.882, which was statistically significant p < (0.001). To predict cardiac length from gestational age we used linear regression analysis. Coefficient of determination was found to be 0.764 that is 76.4% variation in cardiac length can be accounted by knowing gestational age. Regression model was found to be statistically significant with ANOVA test (p <0.001). Coefficient of regression (slope of the regression equation) was also statistically significant (p< 0.001). From Table. 1 equation for predicting cardiac length will be

$$\text{Ln (CL)} = (b) \text{ Ln (GA)} + a$$

It can be concluded that cardiac length growth rate is allometrically positive in relation to fetal age.

Correalation between Cardiac Length and Biparietal Diameter



Graph 2:

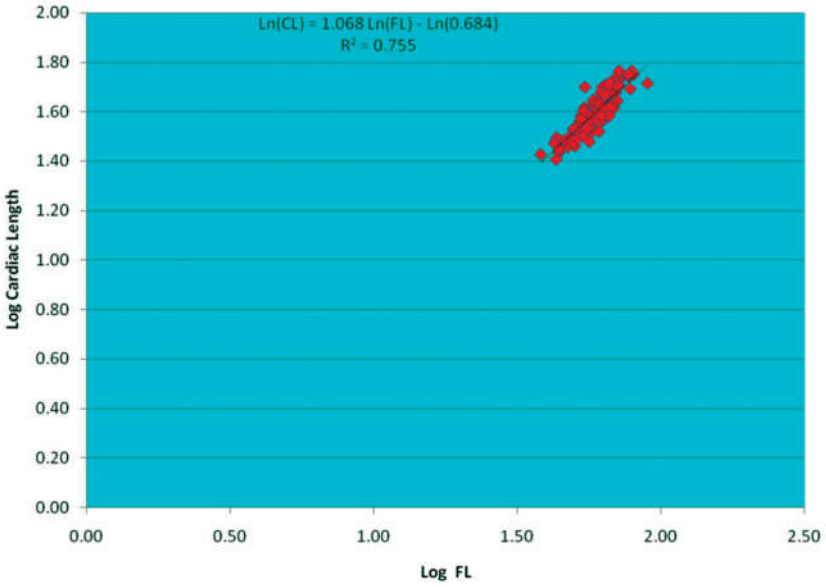
Table 2: Correlations

		Ageusg	Femurlen	Bpd	Ac	Cardialen
Ageusg	Pearson Correlation	1	.897(**)	.852(**)	.796(**)	.882(**)
	Sig. (2-tailed)		.000	.000	.000	.000
	N	132	132	131	130	128
Femurlen	Pearson Correlation	.897(**)	1	.838(**)	.793(**)	.860(**)
	Sig. (2-tailed)	.000		.000	.000	.000
	N	132	132	131	130	128
Bpd	Pearson Correlation	.852(**)	.838(**)	1	.743(**)	.801(**)
	Sig. (2-tailed)	.000	.000		.000	.000
	N	131	131	131	129	127
Ac	Pearson Correlation	.796(**)	.793(**)	.743(**)	1	.771(**)
	Sig. (2-tailed)	.000	.000	.000		.000
	N	130	130	129	130	127
Cardialen	Pearson Correlation	.882(**)	.860(**)	.801(**)	.771(**)	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	128	128	127	127	128

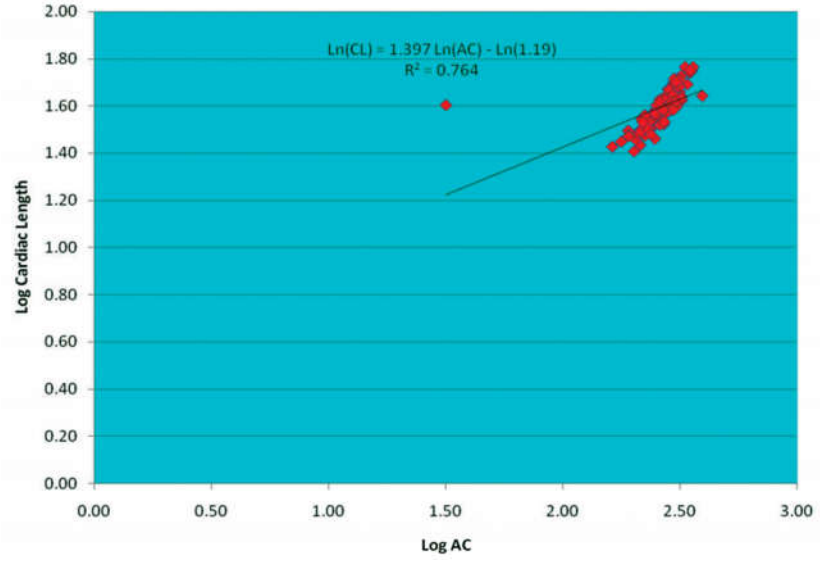
** Correlation is significant at the 0.01 level (2-tailed)

Graph 3:

Correlation between Cardiac Length and Femur Length



Correlation between Cardiac Length and Abdominal Circumference



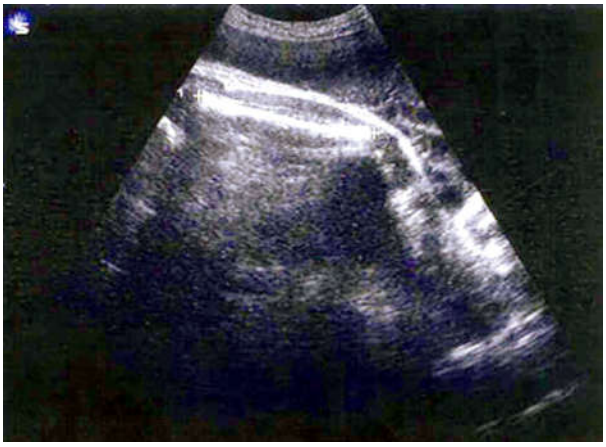


Fig. 1: The femur is measured from the origin to the distal end of the shaft the femoral head and distal epiphysis are not included in the measurement (note the measurement is 71.7mm real time scan)

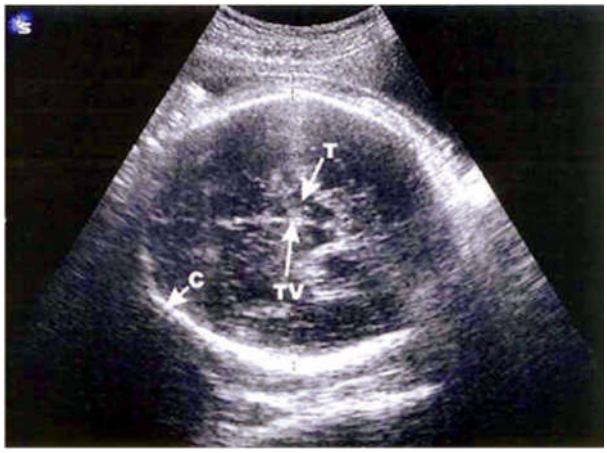


Fig. 2: An accurate biparietal diameter can be obtained through any plane of section that intersects the third ventricle (TV) and the thalami (T). The margins of the calvaria must be (C) symmetric. The first criterion ensures that the plane of section is taken at the proper craniocaudal plane. The second criterion ensures that the transducer is oriented perpendicular to the central axis of the head (note the measurement is 86.1mm, real time scan)

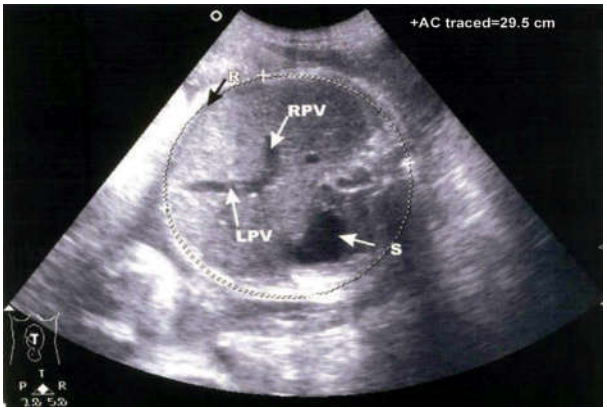


Fig. 3: The rules of measurement of the fetal AC are, the correct cephalocaudal plane is the position where the right and left portal veins are continuous with one another. Second, the appearance of the lower ribs is symmetric. Finally, the shortest length of the umbilical segment of the portal vein is depicted. The body of the fetal stomach is nearly always visible in a well performed AC measurement (note the measurement is 295 mm, real time scan)

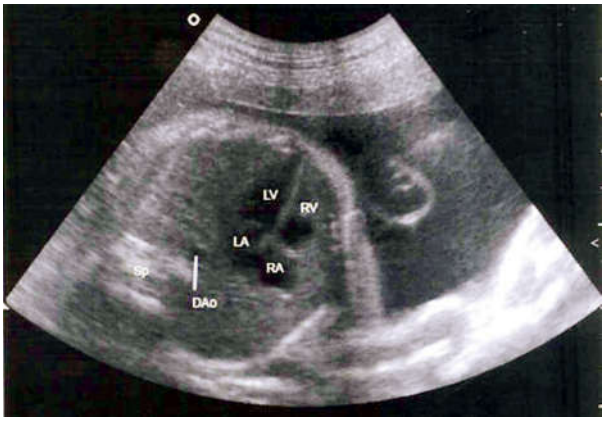


Fig. 4: Normal four chamber view of the fetal heart. The orientation shows the descending aorta (DAo) close to the spine (Sp), the left atrium (LA) anterior to the descending aorta, and the right ventricle (RV) behind the anterior chest wall. The heart covers about one-third of the thoracic cross-sectional area; the apex points to the left anterior chest wall (real time scan)

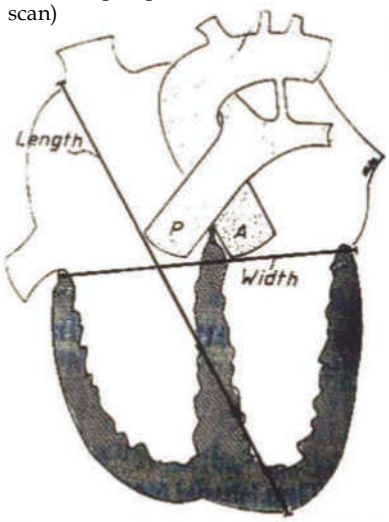


Fig. 5: Schematic drawing of a frontal section of the heart showing where the measurements were taken. Cardiac length between the sulcus terminalis immediate right of the superior vena cava and apex of the heart.

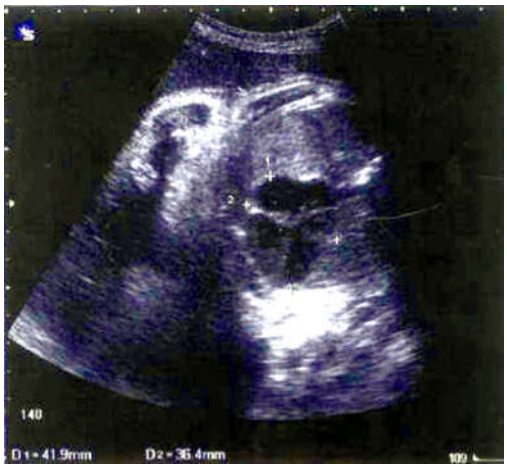


Fig. 6: transabdominal sonographic 4-chamber view of the fetal heart in 24 weeks pregnancy where the measurements were taken. Cardiac length between the sulcus terminalis immediate right of the superior vena cava and apex of the heart.

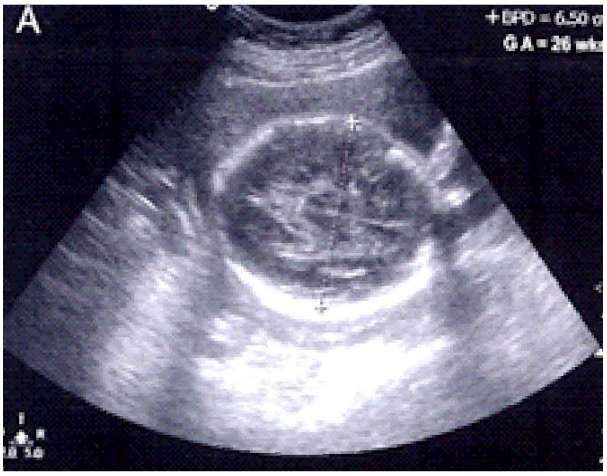


Fig. 7 A: Transabdominal sonographic view of biparietal diameter in a 26 weeks fetus (real time scan)

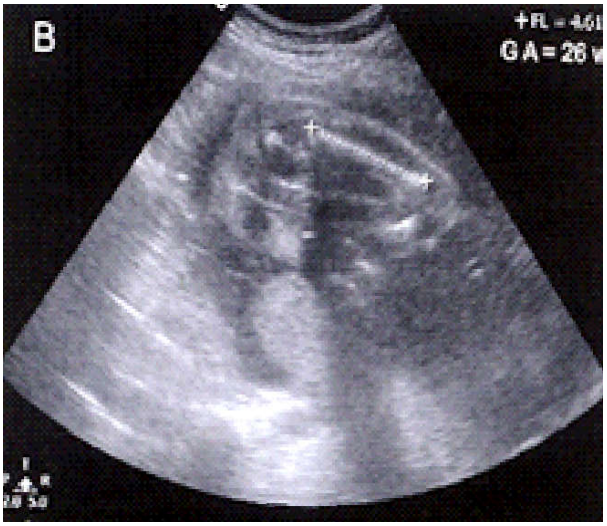


Fig. 7 B: Transabdominal sonographic view of femur length in a 26 weeks fetus (real time scan)

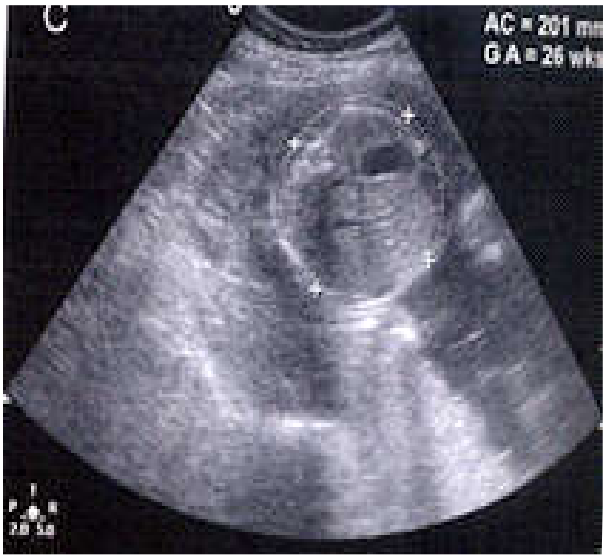


Fig. 7 C: Transabdominal sonographic view of abdominal circumference in 26 weeks fetus (real time scan)

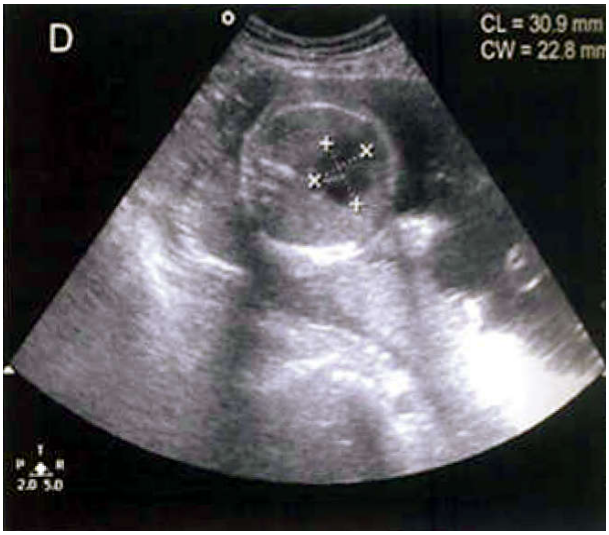


Fig. 7 D: Transabdominal sonographic 4-chamber view of the fetal heart in a 26 weeks fetus (note the cardiac length is 30.9mm real time scan)

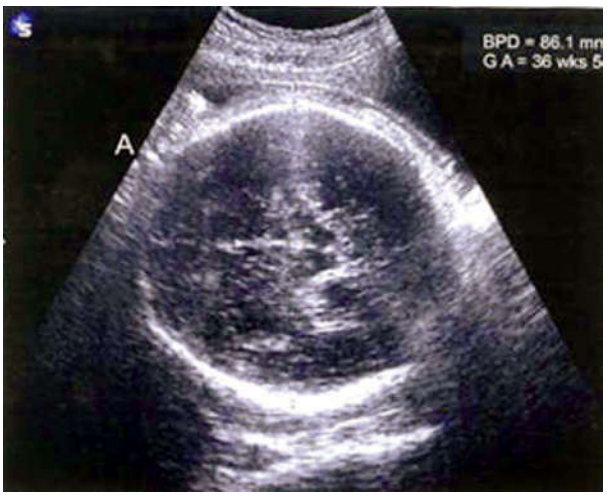


Fig. 8 A: Transabdominal sonographic view of biparietal diameter in 36 weeks fetus (real time scan)

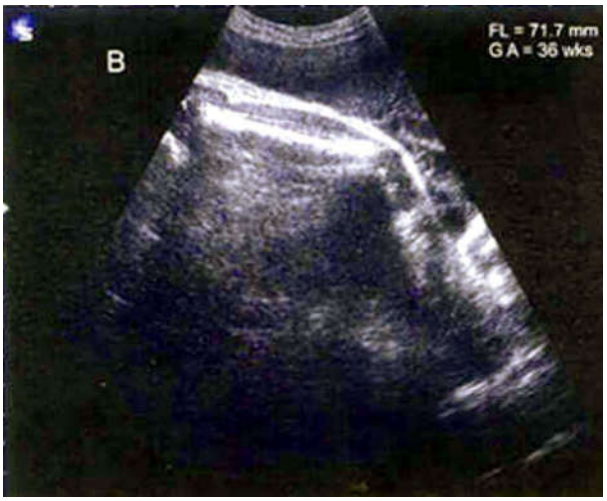


Fig. 8 B: Transabdominal sonographic view of femur length in a 36 weeks fetus (real time scan)

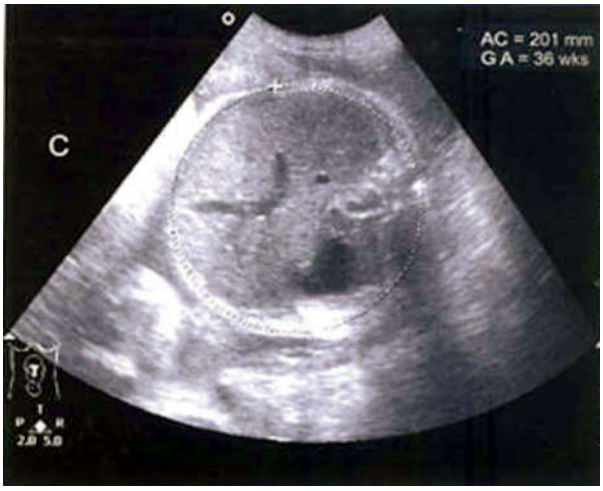


Fig. 8 C: Transabdominal sonographic view of abdominal circumference in a 36 weeks fetus (real time scan)

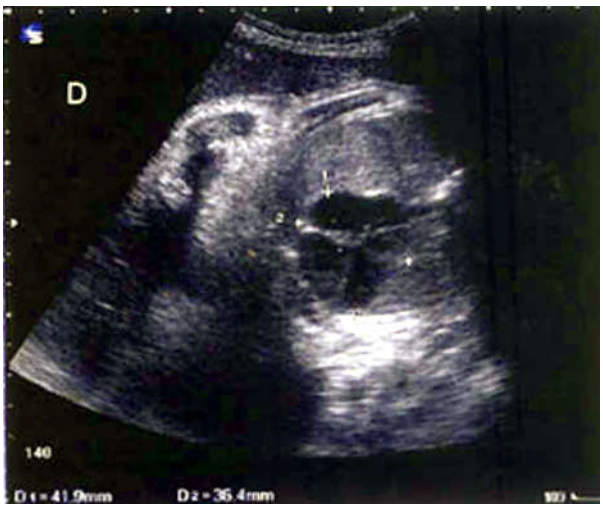


Fig. 8 D: Transabdominal sonographic 4- chamber view of the fetal heart in a 36 weeks fetus (note the cardiac length is 41.9mm real time scan)

Discussion

It is obviously important to understand cross-sectional cardiac images, if possible, in the physiological state, both for the clinician and the anatomist. The clinician can use this knowledge to aid in diagnosis, and the anatomist can use it better to understand and describe subtle anatomical structures that may be difficult to visualize on gross dissection[11].

Allometry is the change in shape with size. The growth of the human heart was proved to be allometrically positive during fetal life. This suggests a high cardiac growth rate in this third trimester period, with major changes in the shape of the heart.

For estimating fetal age and size[12] in general there are three statistical tools used for predicting fetal age or size by sonography – a table or graph, regression formula and a ratio that is used to compare relative sizes of one parameter with another parameter

The last menstrual period (LMP) is the most common method for estimating expected date of delivery for a fetus. The problem with dating of pregnancy is that not all the women have same menstrual length. Stress and anxiety lengthen the menstrual cycle and the time of fertilization and implantation after the LMP varies somewhat. For these reasons, predicting the date of pregnancy from LMP varies from actual sonographic measurement. Naegele's formula is commonly used to estimate the expected date of delivery (EDD). The EDD is by adding seven days to LMP and counting back 3 months.

Presently measuring the multiple fetal ultrasonographic parameters is the most effective way for evaluation of fetal growth and detection of abnormal fetal growth.

Prenatal diagnosis allows time for a thorough counseling and allows the family to make an informed decision regarding continuation or termination of pregnancy, instigation of medical therapies, preparation for postnatal cardiac surgery, and more recently, the possibility of invasive intrauterine interventions such as valvuloplasties [13].

Confirmation of the diagnosis led to a multidisciplinary approach, with involvement of a paediatric cardiologist, a geneticist, and the obstetrician, so that the most accurate information could be given to the parents to help them in the decision-making process [6].

Perioperative morbidity and mortality are lower for prenatally diagnosed cardiac lesions, as delivery can be arranged in a center with adequate neonatal resuscitation and surgical facilities [13].

In the present study four chamber view of the heart was selected. It has been suggested that incorporation of the four chamber view of the fetal heart into routine obstetric scanning may improve the diagnostic rate of congenital heart disease. The highest incidence of (50)% of congenital heart disease occurs in cases referred because of a suspected congenital heart disease on a routine ultrasonographic scan [6].

Wernovsky et al., mention that a continuation of the application of the arterial switch operation to patients with transposition of the great arteries with or without VSD, as early in life as is possible, is indicated [14].

Brawn and Mee et al., advocate anatomic repair of TGA-VSD and DORV-VSD before 3 months of age to correct symptoms of congestive failure to thrive and

to prevent the development of pulmonary vascular disease [15].

It is well known that early neonatal diagnosis and treatment of congenital heart disease can improve outcome, especially when complex malformations are present [7].

An increasing number of obstetricians are performing fetal screening scans that include a four-chamber view of the heart. This has led to a large increase in the number of referrals for fetal echocardiography [16].

Postnatal survival in newborns with critical congenital heart disease largely depends on the timely initiation of specific treatment. Prenatal diagnosis followed by delivery at a tertiary care institution with an expertise in management of newborns with heart disease allows timely institution of specific treatment [17].

In the present work the cardiac 4-chamber view was studied by the traditional transabdominal scan because the heart is large enough in third trimester to be well examined with this technique. The transabdominal approach is a simpler and less expensive method to evaluate the pregnancy and the developing fetus than is transvaginal sonography.

The transversal heart diameter, ventricular dimensions, interventricular septal thickness, heart area, cardiothoracic diameter ratio, aortic diameter and the pulmonary trunk diameter showed a highly significant linear correlation to the gestational age and the biparietal diameter [18].

The introduction of high quality equipment [19], as well as better understanding of fetal anatomy and physiology, has resulted in improved accuracy of fetal echocardiography in recent years. In fact, accuracy of complete anatomic assessment is now possible after 18 to 20 weeks gestation [20]. False positive prenatal diagnosis of anatomic heart disease is rare [21].

In the present study quantitative analysis of fetal heart was carried out in the randomly selected 132 pregnant women who came for routine antenatal sonography. Growth of the cardiac measurements and fetal parameters were explored by allometry and linear regression analysis. Gestational age is assessed by BPD, FL, and AC as per norms in one of the Mumbai's medical teaching institute and tertiary care centre. Then the cardiac length were correlated with gestational age, BPD, FL, and AC.

In above study growth of the cardiac measurements and fetal parameters were explored by allometry and linear regression analysis [1].

In present study relationship between gestational age and growth of cardiac length was explored by allometry and linear regression analysis (Table 1). This method uses an independent variable(X) to predict the value of a dependent variable (Y).

Here independent variable GA, BPD, FL & AC was used to predict dependent variable CL. Correlation between cardiac length and gestational age, biparietal diameter, femur length & abdominal circumferance was assessed by using Pearson's correlation coefficient it was found to be positively correlated (Table 1,2 & Graph 1,2,3 & 4). Regression model was found to be statistically significant with ANOVA test ($p < 0.001$). Coefficient of regression (slope of the regression equation) was also statistically significant ($p < 0.001$). Thus it was concluded that cardiac length growth rate was allometrically positive in relation to fetal age, BPD, FL & AC.

Similar previous study, Sonographic quantitative analysis of the heart in the third trimester of gestation by Mandarim-de-Lacerda CA et al., in which fetal parameters were BPD , FL. In the study by Mandarim-de-Lacerda CA et al., linear regression of the increase of the cardiac length relative to gestational age was done in which slope (b) was found to be 1.458, intercept was -1.701, 95% confidence interval for b was 1.207-1.709 and coefficient of regression was found to be 0.851.The present study result matches with that of the above mentioned study.

There was significant correlation seen in the dependent parameters i.e. cardiac length and independent parameters i.e. gestational age, biparietal diameter, femur length and abdominal circumference (Table 2).

Allometry is the change in shape with size. The growth of the human heart was proved to be allometrically positive during fetal life. This suggests a high cardiac growth rate in this third trimester period, with major changes in the shape of the heart[1].

Summary and Conclusions

Advanced technology as well as increased capability of sonographers and sonologists have expanded the use of ultrasonography as a diagnostic obstetric tool for the evaluation of fetal anatomy. The uses of ultrasonography are varied; in obstetrics, its use has become crucial and vital especially in accurate determination of gestational age in women with unknown last menstrual period.

The fetal heart was studied with transabdominal sonography in 132 single normal pregnancies in third trimester. The third trimester was considered from

24 weeks to term covering four age groups viz. 24-27.9 weeks (22 fetuses), 28-31.9 weeks(50 fetuses), 32-35.9 (50 fetuses), 36-40 weeks (10 fetuses).

Measurement of cardiac length (major longitudinal diameter) of the heart was taken. Gestational age was assessed by fetal parameters that are biparietal diameter, femur length and abdominal circumference as per the norms in one of the Mumbai's medical teaching institute and tertiary care centre.

Relationships between the cardiac data and fetal age, biparietal diameter, femur length and abdominal circumference were explored by allometry and linear regression analysis in order to estimate cardiac growth rates during third trimester. The length of the heart could be measured reproducibly in the 4-chamber view of the heart.

The cardiac length was 30.9mm in fetuses up to 26 weeks. These measurents were seen to gradually increase as the fetuses advanced such that at 36 weeks of gestation it was seen to be 41.9mm (Fig. 7 & 8).

There was significant correlation seen in the dependent parameter i.e.cardiac length and independent parameters i.e. gestational age, biparietal diameter, femur length and abdominal circumference.

This study verified that the heart grows very rapidly during the third trimester (positive allometry). The linear increase of the fetal heart shows a strong and significant correlation with the increase of biparietal diameter, femur length and abdominal circumference.

This suggests that noninvasive analysis of cardiac data can be useful for the assessment of gestational age or for prenatal detection of congenital heart disease.

Aknowledgment

I would like to thank Dr. Pritha Bhuiyan, Professor & Head, Department of Anatomy Seth G S Medical College & KEM Hospital Mumbai.

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Supplementation of Dissection Videos and Simultaneous Osteology Teaching to Improve the Concepts of Anatomy During Routine Classroom Dissections in First M.B.B.S. Students

Sumedh Ganpat Sonavane*, Rupali Shantaram Kavitake*, Medha Vijay Ambiye**

Abstract

The provision of learning gross anatomy in medical colleges provides an emotional as well as intellectual approach to medical education. The teaching of gross anatomy has, for centuries, relied on the dissection of human cadavers. Past research suggests that students find work on a cadaver to be distressing, but also rewarding. Hands-on educational experiences on cadavers can also stimulate student's interest, increase knowledge retention and enhance development of clinical skills. Learning on human cadavers is complex learning experience and is not easy to quantify and evaluate objectively.

Such aspect pertains to question of professionalization, social skill and attitude towards death. There have been pro and con arguments on whether medical students should dissect the whole body or learn from pre-dissected bodies. The present study is an attempt to improve the concepts of Anatomy by supplementation of dissection videos and simultaneous osteology teaching during routine classroom dissections.

Keywords: Dissection-Videos; Osteology; Cadaveric-Dissection; Complex-Learning; Structured-Assessments; Medical-Education.

Introduction

The provision of learning gross anatomy in medical colleges provides an emotional as well as intellectual approach to medical education. The amount of Anatomy teaching required in undergraduate curriculum and the best way to impart this knowledge are issues that are frequently debated by medical community [1].

The teaching of gross anatomy has, for centuries, relied on the dissection of human cadavers [2]. Past research suggests that students find work on a cadaver to be distressing, but also rewarding [3]. Hands-on educational experiences on cadavers can also stimulate student's interest, increase knowledge retention and enhance development of clinical skills [4].

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With increasing number of medical colleges and increased demand for cadavers together with technological advancement, utility of dissection has generated discussions, more so in recent past, with favours growing towards the use of multimedia tools, computer software packages, models including plastinated specimens and imaging techniques[5,6,7,8,9]. The proponents of latter methods substantiate the views on the continuation of practice of dissection for and against rather convincingly [10].

Anatomical dissection is systematic exploration of preserved human cadaver by sequential division of tissue layers and liberation of certain structures by removal of regional fat and connective tissue with the aim of supporting the learning of gross anatomy by visual and tactile experience. Learning on human cadavers is complex learning experience and is not easy to quantify and evaluate objectively. Such aspect pertain to question of professionalization, social skill and attitude towards death [11]. There have been pro[6,12] and con [13,14] arguments on whether medical students should dissect the whole body or learn from pre-dissected bodies.

The present study is an attempt to improve the concepts of Anatomy by supplementation of

dissection videos and simultaneous osteology teaching during routine classroom dissections.

Context of the Study

The potential of a cadaveric dissection to give better understanding of Anatomy to medical students is remarkable.

The aim of the present study is to identify a strategy that makes dissection not only interesting but also more purposeful, clinically oriented and contribute more to the overall understanding of human anatomy within a limited time period. This approach would also make students enthusiastically participate in the dissection, comprehend and communicate the anatomical facts and grasp the clinical bearing of the part under dissection.

Aim

To improve the concepts of Anatomy in first M.B.B.S. students

Objectives

1. To give exposure for relevant dissection videos to the study group of students prior to the routine classroom dissections.
2. To expose simultaneous relevant osteology teaching to the study group of students during routine classroom dissections.
3. To assess the study group and control group of students separately on the same topics by structured Theory (M.C.Q. and S.A.Q.) and Viva-voce.
4. To compare the scores of study group and control group of students.
5. To have a feedback from the study group and control group of students regarding the teaching-learning methods after the assessment.
6. To discuss the scope and limitations of implemented teaching-learning method towards the improvement in concepts of subject.

Material and Methods

The present study sample consisting of 40 medical undergraduates of first year bachelor of medicine and bachelor of surgery (I M.B.B.S.), in preclinical phase of five years bachelor entry course at Topiwala National Medical College, Mumbai – 400 008.

These students were divided into two groups (20 study group and 20 control group with at least 75% of attendance during the study). Both groups were of equal size with similar age and sex composition and also similar prior academic performance in terms of overall percentage obtained in high school (Grade II) passing examination.

A pre-test was conducted in the form of questionnaire about basic concepts of relevant topics in Anatomy to ensure that there is no statistical difference between baseline knowledge in Anatomy and learning ability between the two groups.

Study group of students were exposed for relevant dissection videos prior to the routine classroom dissections in addition to traditional / conventional methods.

Study group of students were also exposed for simultaneous osteology teaching during the routine classroom dissections.

However the control group of students were dissected by the traditional / conventional method using Cunningham's manual for dissection[15] and also exposed for separate i.e.in isolation osteology teaching (as it is a routine practice i.e. traditional / conventional method).

Both these groups were assessed separately by conducting a Post-test covering the topics i.e. at the end of superior extremity dissection by structured Theory (M.C.Q. and S.A.Q.) and Viva-voce.

The post-test was conducted by a teaching faculty in subject of Anatomy and previously unrelated to the present study to avoid evaluator's bias.

The scores obtained in percentage in two groups were compared by applying 'Z' test [16].

The data gathered from the questionnaire i.e. feedback was analyzed.

The scope and limitations of the implemented teaching-learning method were discussed.

It was also noted that both groups had equal number of total hours available for dissection and equal time duration for self study. Informed written consent was obtained from all the subjects. Students from control group were not deprived of new methodology since they were also exposed for the teaching methodology implemented for study group after the assessment. Cadavers used in the study were obtained by the body donation program of our department and unclaimed bodies received in the department following all ethical guidelines. There were no dropouts from the study.

Results

Evaluation

A pre-test was conducted in the form of questionnaire about basic concepts of relevant topics in Anatomy.

A post-test was conducted covering the topics with structured Theory (M.C.Q. and S.A.Q.) and Viva-voce. The percentages of scores obtained in two groups were compared by applying 'Z' test [15].

Student's feedback was taken pertaining to various aspects of implemented Teaching – Learning method using a questionnaire having 3 point Likert's Scale and by asking close ended questions.

A pre-test result showed that there is no statistical difference between baseline knowledge in Anatomy and learning ability between the two groups.

The Post-Test results shows statistical significant difference at must know, desire to know and nice to levels of questions in multiple choice questions, short answer questions and viva-voce. Study group students are the high achievers.

The above table shows that the implemented Teaching-Learning methodology was very well accepted by the students which leads to better understanding, improvement of the concepts and outcome during assessment.

Table 1: Pre-Test result-percentage of correct answers

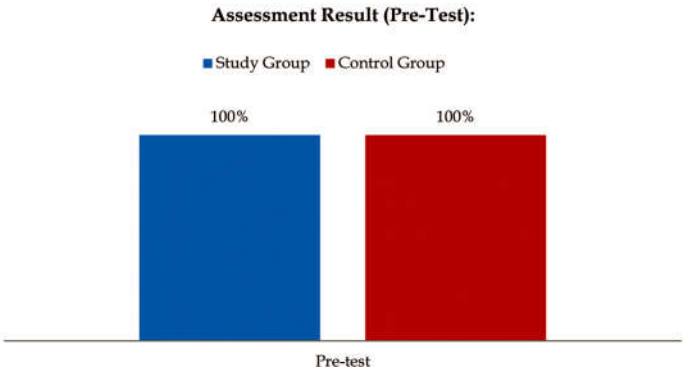
Groups	Total No. of Students	Pre -test (Percentage of correct answers)	'Z' Value	'p' value
Study Group	20	100%	00	p > 0.05
Control Group	20	100%		

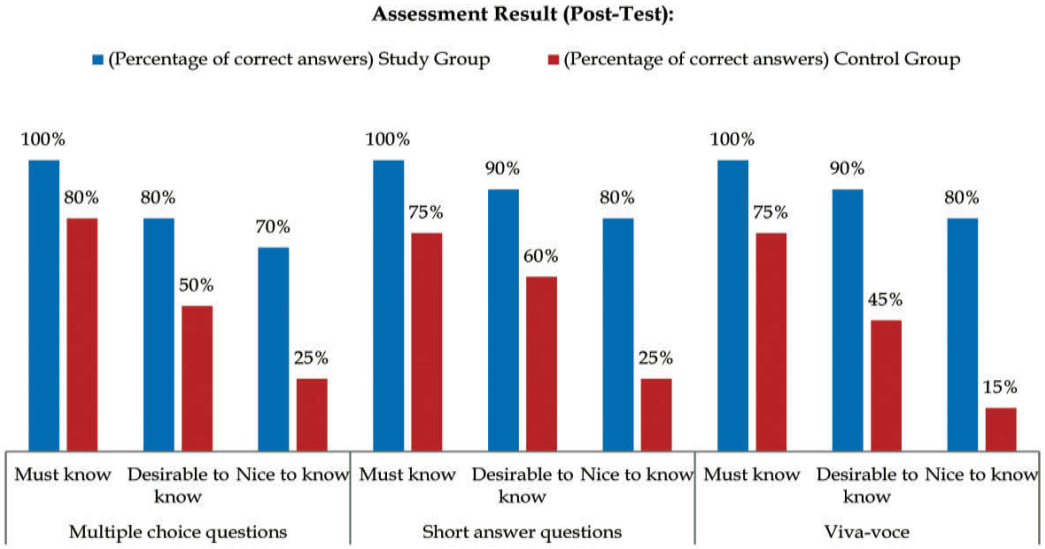
Table 2: Assessment result (Post-Test)

Assessment Methods	Type of questions	Groups (Percentage of correct answers) Study Group	Control Group	'Z' Value	'p' value
Multiple choice questions	Must know	100	80	09.17	p < 0.05
	Desirable to know	80	50	14.79	p < 0.05
	Nice to know	70	25	14.46	p < 0.05
Short answer questions	Must know	100	75	09.93	p < 0.05
	Desirable to know	90	60	13.17	p < 0.05
	Nice to know	80	25	13.52	p < 0.05
Viva -voce	Must know	100	75	09.93	p < 0.05
	Desirable to know	90	45	13.32	p< 0.05
	Nice to know	80	15	12.30	p < 0.05

Table 3: Percentage of answers of questionnaire (study group)

Sr. No.	Questionnaire	Yes (%)	Not Sure (%)	No (%)
1.	Do you think that supplemented Teaching-Learning method is helpful towards the improvement in understanding of the topics?	100	00	00
2.	Do you think that retention of the topic would be better by this Teaching-Learning method?	100	00	00
3.	Whether the implemented Teaching-Learning method is useful for recalling memory to answers of multiple choice questions?	100	00	00
4.	Whether the implemented Teaching-Learning method is useful in writing the theory examination?	100	00	00
5.	Whether the implemented Teaching-Learning method is useful for recalling memory to answer in viva-voce?	100	00	00
6.	Whether the topics covered by the implemented Teaching-Learning method within the stipulated time?	100	00	00
7.	Whether the implemented Teaching-Learning method is useful to recall the information for clinical correlation of the topics?	95	05	00
8.	Whether the implemented Teaching-Learning method has increased your interest towards active participation in dissection?	100	00	00
9.	Would you like to opt the implemented Teaching-Learning method for remaining topics?	95	05	00
10.	How do you rate the implemented Teaching-Learning method?	Very Good (90%)	Good (05%)	Fair (0%) / Poor (0%)





Annexure: I

Informed Consent

I, Mr./Miss. ……...

Age: …… years hereby voluntarily and willingly give my consent to participate in the curriculum innovation project entitled **"Supplementation of dissection videos and simultaneous osteology teaching to improve the concepts of Anatomy during routine classroom dissections in first M.B.B.S. students"** being conducted by **Dr.Sumedh G. Sonavane** in the department of Anatomy.

I have been explained about the project and have understood that the purpose of this study project is for educational research only and that the information provided by me shall be treated with total confidentiality and that it shall be used purely for academic purpose only and shall not have any effect on my academic performance. I have also been explained that my identity shall not be revealed.

In this project I am willing to participate with full attendance. I have given my consent in complete consciousness and without being under any pressure.

Signature

(Name: ……..)

Date: / /
Place: Mumbai – 400 008

Annexure: II

Feedback Form for Studygroup Students

(Please give your valuable feedback about implemented Teaching-Learning methodology)

Instructions:
Please mark the single best response for each of the following questions.

Sr. No.	Questionnaire	Yes	Not Sure	No
1.	Do you think that supplemented Teaching-Learning method is helpful towards the improvement in understanding of the topics?			
2.	Do you think that retention of the topic would be better by this Teaching-Learning method?			
3.	Whether the implemented Teaching -Learning method is useful for recalling memory to answers of multiple choice questions?			
4.	Whether the implemented Teaching-Learning method is useful in writing the theory examination?			
5.	Whether the implemented Teaching-Learning method is useful for recalling memory to answer in viva-voce?			
6.	Whether the topics covered by the implemented Teaching-Learning method within the stipulated time?			
7.	Whether the implemented Teaching-Learning method is useful to recall the information for clinical correlation of the topics?			
8.	Whether the implemented Teaching -Learning method has increased your interest towards active participation in dissection?			
9.	Would you like to opt the implemented Teaching -Learning method for remaining topics?			
10.	How do you rate the implemented Teaching-Learning method?	Very Good	Good	Fair	Poor

Discussion

Dissection of a human cadaver is a time–honored tradition for teaching anatomy in medical education. However, in recent years, for variety of reasons, including costs and ethical concerns, some medical programs have ceased cadaver dissection in exchange for virtual dissection of cadavers in cyberspace [3]. The traditional anatomy education based on topographical structural anatomy taught by didactic lectures and complete dissection of the body with personal tuition has been replaced by a multiple range of special study modules, problem-based workshops, computers, plastic models and many other teaching tools.[17] The paucity of cadavers is also weighing the practice of dissection. In an era where the methods and time dedicated to the teaching of human anatomy are changing within medical curricula worldwide, it behooves anatomists to device alternative strategies to effectively teach the discipline to medical students [17]. The student's participation and the instructor's interest get affected as confusion prevails due to lack of time. Further, dissection can be edited to make it more purposeful by making it more clinically relevant [18]. Various workers have tried and tested methods that inadvertently attempt to redeem dissection.

The faculty of anatomy at the University of North Texas health Science Centre (UNTHSC) has developed a computer based dissection manual to adjust to their curricular changes and time constraints. Although they place a high priority on computerization on the anatomy laboratory, they remain strong advocates of the importance of cadaver dissection [7]. Ellis emphasizes the teaching in the dissecting room [6]. Likewise, McGarvey and colleagues hold dissection as a positive experience and towards this they have prepared strategies that cope with the stress in the dissection hall [5].

Pratten et al and R. Bhatnagar et al studied shows that students who had undertaken weekly inter course assessments showed significantly improved summative marks compared with those who did not [18,19]. Another study shows that medical students grade dissection as the best method to learn anatomy compared to newer approaches such as models, computer software packages, living and radiological anatomy [20].

The time constraint has compelled the traditional teacher to only teach anatomy that is going to be clinically relevant to them in their subsequent practice [9]. The dissection room teaching when complimented by structured tests would make the student focused for learning and enthusiastically participate in dissection within the given time frame. Chakravarty et al [21] have recommended assessment of anatomy in a problem based curriculum has been implemented since 1982. They have used several methods to assess

the different domains of learning that is knowledge, skill and attitudes using multiple-choice questions, patient managements problems and objective structured practical examination. They acknowledge that training should be based on 'applying processes of reasoning than by memorizing of the facts'.

Arora L and Sharma BR [1] noted that both M.B.B.S. and B.D.S. students found dissection as a tool that helps them in better understanding of Anatomy and provides to visualize different organs of human body and their relationship.

Present study was conducted at Topiwala National Medical College on a small sample with simple counting methods, which enabled to focus on detailed description and their meanings. Thus present findings may not be widely generalisable but is valuable in generating important educational issues.

Since the present study conducted on a limited portion cvered in around one month hence the student can gauge his/her own performance vis-à-vis the efforts put in the dissection hall during one month. The students start taking active part in dissection. It gives the student an impetus to do better in the next session. The student's efforts are guided by desire to do well for which he/she is compelled to participate in every day's dissection. Outcome of each dissection was neat and better exposed structures. Each dissection becomes purposeful. The keenness to learn about the clinical aspect is the driving force to enter the dissection hall with enthusiasm and meet the learning objectives. The effort to structure the assessments in sets, which is to identify, seek and show, demonstrate and explain, has yielded good response and it has prompted to apply the implemented methodology to entire body dissection.

The credibility of the implemented Teaching–Learning methodology depends upon the objectivity achieved and their bearings in the final assessment of the student. This necessitated designing the methodology for testing comprehension rather than memorization of the facts. Hopefully, this methodology when implemented at university level would curtail the hither to practice where there is very little objectivity and uniformity and the students are at the whims and mercy of the examiner.

Conclusion

The potential of a cadaveric dissection to give better understanding of Anatomy to medical students is remarkable.

The threat to wreck havoc on the very edifice of medical education is to be countered by making dissection indispensible. It is to be achieved by following a planned strategy that makes the student realize the importance of dissection and to increase their curiosity and understanding culminating into better performance in examinations (The present study supports it). Over the years each Institution / University would modify, change and evolve a pattern that would bring in uniformity and objectivity in both conduction of dissection classes and assessments.

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I am grateful to the entire faculty of IMETT, MUHS Pune Regional Centre for their guidance and support for this project right from its conception to completion. I would also like to extend my sincere thanks to the volunteers of first M.B.B.S. Students from T. N. Medical College, Mumbai- 400 008 who were the active participants of the present study and also my family members who were supported for timely completion of the same. It has indeed been a great learning experience.

Conflicts of Interest

All authors have none to declare.

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Simple Way to Instruct Newly Admitted Medical Students

Sharadkumar Pralhad Sawant*, Shaheen Rizvi**

Abstract

Traditionally Anatomy teaching consists of didactic lectures as well as dissections or prosections as per the requirement of the course. Lecture is defined as an oral discourse on a given subject before an audience for purpose of instruction and leaning. In the traditional method lectures were taken via chalk & board, but nowadays power point presentations are increasingly being used. Anatomy is the base of medical science in India and is taught practically to all disciplines of undergraduate health sciences in the first year. It is an acknowledged fact that a basic knowledge of Anatomy is a prerequisite to learn any other branch of medicine. All medical professionals must have a basic knowledge of Anatomy so as to ensure safe medical practice. To make Anatomy learning both pleasant and motivating, new methods of teaching gross anatomy are being assessed as medical colleges endeavour to find time in their curricula for new content without fore-going fundamental anatomical knowledge. This paper examines the other teaching methodologies for teaching gross anatomy. *Conclusion:* Proper utilization of newer technologies along with the traditional teaching methods will certainly lead to enhanced understanding of gross anatomy and will ultimately improve students' performance.

Keywords: Anatomy; Medical Science; Newly Admitted Medical Students; Medical Professionals; Medical Practice; Traditional Methods & New Methods of Teaching.

Introduction

Anatomy is the base of medical science in India and is taught practically to all disciplines of undergraduate health sciences in the first year. It is an acknowledged fact that a basic knowledge of Anatomy is a prerequisite to learn any other branch of medicine. All medical professionals must have a basic knowledge of Anatomy so as to ensure safe medical practice. It is an innate challenge teaching Anatomy. Firstly, Anatomy is a subject in which students have to learn many new concepts and complex terminologies making it difficult. As a result, they find it monotonous and painstaking and concentrate their efforts on "memorizing" the lists of new terminologies. Secondly, the recent changing face of medical education has lead to a reduction in the hours of teaching Anatomy. Thirdly, students are extremely diverse with respect to their grades, their scientific literacy levels, their abilities, their cultural backgrounds and professional fields. Hence it remains a challenge to find and assess methods to teach *all* students anatomy more effectively, in less time, and often with limited resources [1]. The fundamental approach to teaching Anatomy is the use of human cadavers. Cadavers are indispensible to the study of human Anatomy. With increasing awareness of voluntary body donations, there is no dearth of cadavers and students in India get ample opportunities for dissection[2]. Anatomy as a subject not only requires surface learning or memorisation but also requires deep learning through understanding and the ability to apply the information to solve clinical problems [3]. For effective learning of Anatomy, students need to be engaged and sustained in significant learning activities through interaction with other students. Having interested and zealous teachers is also crucial to sustaining a students' interest.

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Discussion

Didactic Lectures have been a universal form of teaching and learning since ancient times, especially for large group teaching, when the number of students attending is much larger than the number of teachers available. Lecture is defined as an oral discourse on a given subject before an audience for purpose of instruction and leaning. During a lecture, both the visual and auditory senses are used to absorb information. In the usual course of teaching, the most frequently used method is of taking didactic lectures is the chalk and board method, while the use of transparencies with an overhead projector (TOHP) is also popular. Nowadays the use of PowerPoint (PPT) presentations is the most popular electronic presentation used. Some students prefer PPT presentations, mainly because they evade the issue of poor handwriting and dirty blackboards, but students develop into passive observers rather than active participants. Although use of PPT has some constructive effects, it reduces the interactive dialogue between teacher and students. On the other hand majority of students favour chalkboard teaching not only because of the improved student-teacher interaction but also lectures using chalkboard, contained natural breathers or breaks (eg, during writing or rubbing out the blackboard) allow students to follow the material and take down their notes. Hence, a chalkboard is said to be more student-centered while PPT is more teacher-centered [4,5]. This is also followed in all colleges as one of the traditional teaching method for anatomy. Anatomy teaching in medical schools has been traditionally based around the use of human cadaveric specimens, either taking the whole body specimens for complete dissection or as prosected specimens. Cadaveric dissection is central and indispensable to the study of human anatomy. The concrete foundation of medicine comes from a sufficient and very accurate knowledge of human anatomy and this can be achieved only from learning human dissection. Thus dissection training has remained an significant part of medical curriculum. In addition, cadaveric dissection allows students to not only grasp the three -dimensional anatomy and but also the concepts of biological variability. Through dissection, students are able to envision firsthand, the actual structures of the human body. The manual dexterity learnt in the dissection room are vital in almost every branch of medicine and thus dissection has remained a globally indentifiable step in becoming a doctor [6,7]. Cadavers are embalmed with formaldehyde, a hazardous chemical, and carry the risk of accidental overexposure. Hence some medical schools in the west, began to explore alternative methods for teaching Anatomy. In some schools, dissection has been substituted by plastinated specimens. Plastination, a method invented by Gunther von Hagens, makes it possible for prosections or slices of cadavers to be conserved in a safe, strong, dry polymer medium that is odourless and inert. Plastinated specimens appear like a perfect choice, as the specimens allow students to see a high degree of anatomical specificity, even though they are dry, odourless, and non-toxic. Although the expenditure of acquiring the collection of plastinated specimens is significant, the specimens have a life span of twenty years or longer. There are no recurring costs such as those of cadaver acquisition and embalming associated with a dissection laboratory. But dissection is considered to be a far superior tool to achieve anatomical knowledge. According to Professor Harold Ellis, of London: ''Dissection teaches the basic language of medicine and some manual dexterity. It introduces an understanding of three-dimensional anatomy and the concept of biological variation. It acclimatizes students to the reality of death and teaches respect for the body"[8,9]. To teach complicated and intricate areas of the human body eg Perineum, the traditional cadaveric dissection, may not be enough. For such topics, a dissection video is prepared which not only shows the steps of dissection, but also 2D diagrams of sagittal and coronal sections. Simultaneously a 3D model can also be shown to the students. All these aids help to simplify the topic. These kind of audio-visual aids are complementary to the traditional modes of teaching, A digital anatomical teaching tool with the combination of dissection, 2D diagrams and the demonstration of the 3D model adds to the perception of that region [10]. Medical imaging technologies, such as Radiographs, CT, MRI and ultrasound disclose both normal and pathological anatomy. Teaching radiographic anatomy to pre-clinical medical students is essential, as it correlates anatomical studies to clinical medicine and simultaneously prepares them for the radiology they will come upon in their clinical years. The most extensively used medical imaging modality in anatomy teaching is radiographs. It is a vital part of all anatomy teaching programs. Plain radiographs allow students to study primarily skeletal anatomy. The study of soft tissue anatomy using radiographs rely on the use of contrast, in studies such as barium meal, barium enema, intravenous urogram, hysterosalpingogram, etc. Radiographs and Ultrasound are non-invasive methods of morphological study to supplement the teaching of

gross human anatomy. They allow students to visualize 'living anatomy' through correlations with cadaveric dissection. Students can use radiographs and ultrasound to learn normal anatomy of the thorax, abdomen, pelvis, and extremities. CT and MRI images initiate the study of sectional anatomy, and transform the three dimensional structures and relationships into two-dimensional representations and help the students to understand the concepts better. Students will have the opportunity to correlate these sectional images side by side with the dissected or prosected specimens. They facilitate a better understanding the anatomy of the spine as well as the study of neuroanatomy. Integrating these medical imaging modalities in the study of anatomy is fitting, not only because they recommend ways of visualizing the anatomy of living subjects, but also because they are the very same diagnostic resources which the students will use in their clinical years and in their practice [11,12]. Students get encouraged when they see the application of what they are doing and are likely to retain the information, because they are learning it in context. Problem based learning was developed on these grounds [13]. A given 'problem' often a clinically related one, is given to the students and from this problem, students are left to explore different topics and learn the different facets of the problem. e.g. – An elderly lady falls and fractures her leg may be the problem. From this, the students will learn the anatomy of the lower limb, pathophysiology of bone healing, pharmacology of pain relief, the risks of immobilisataion in the elderly and the consequences of disability. This type of approach is being progressively adopted by many medical colleges. It also helps the pre-clinical students to improve their clinico- pathological skills early in the profession. At the end of the day, it is the problem-solving skills rather than memory based learning which are crucial for treating patients [14,15]. Evidence is available to show that knowledge retrieval is facilitated when knowledge is acquired in a situation resembling those in which it will be applied. By heading in the direction of integrated learning, anatomical details may be reduced but the ability to apply knowledge increases [16,17]. Students secure what they learn by looking at the surface anatomy relevant to the area on themselves, or on each other. Surface anatomy is the study done on the surface of the subject by inspection, palpation and manipulation, in relation to the anatomy under the skin. It brings forth students' interest in gross anatomy, showing them what they learned from books, lectures, and dissection are actually present in living persons. Although the facts are apparent and should need no convincing, the students still show astonishment and elation, when they first 'discover' what lies under the skin. This informs us that surface anatomy is an invaluable method of instruction. Living Anatomy forms the obvious connection between basic gross anatomy and clinical practice, because it is the basis of physical examination [18,19]. Inspite of all the above methods, a number of students still find Anatomy difficult to comprehend. For such students various methods can be employed to facilitate their learning. Those students who are mainly visual learners or artists, such students are encouraged to draw anatomical drawings or what they visualise during dissection, on a board or on paper. This is a valuable learning tool for them and allows them to recapitulate and combine concepts and facts to make them easier to learn. These visual cues also assist with long-term retention of information. Those students who are mainly tactile learners, such students are given models to study or they themselves are encouraged to prepare models using moulding clay. This approach is enjoyable and reinforces learning, while developing a real 3-D image of structures and their relationships. For those students who prefer learning by 'doing', they can be taught Anatomy by performing body movements with weights or by performing movements of the various joints of the body. This 'doing' assists in long term retention of information for many students [20, 21].

Conclusion

Proper utilization of newer technologies along with the traditional teaching methods will certainly lead to enhanced understanding of gross anatomy and will ultimately improve students' performance. The advanced teaching methodologies will help in learning anatomy in a better and an easier way. If these new view points on teaching methodologies are employed, the environment for learning Anatomy will not only be appealing and interesting but also exciting and enjoyable, leading to deeper learning Students will accomplish the desired learning outcomes, and will gradually become positive and self-directed learners.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

SPS drafted the manuscript, performed the literature review & SR assisted with writing the paper.

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A Cognitive Level of Essay Questions and Item Writing Flaws in MBBS University Anatomy Question Papers: An Analytical Study

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Abstract

Background: Assessment drives learning. Reliable and valid question papers of higher cognitive function are difficult to produce, particularly for assessment of clinical problem solving. The present study was undertaken to analyze the essay questions and item writing flaws in the summative anatomy question papers. *Methodology:* 4 years Summative assessment question papers were collected and analyzed, (16 question paper and 32 essay questions) for cognitive level and item writing flaws by two assessors separately. Essay questions were analyzed according to modified blooms taxonomy of cognitive levels and by using validated checklist items. Item writing flaws were analyzed using validated checklists. The results were analyzed using SPSS software. *Results:* Among 32 essay questions analyzed, all of them were at level 1 of cognitive level of Bloom Taxonomy. Majority of questions addressed the competency that could be assessed only with essay question, were aligned to learning outcomes, structure and pertaining to must know aspects of curriculum. Out of 32 essay questions 17.2% were of average, 51.7% were good and 31% were of excellent quality. In connection with item wise flaws, majority of questions were ambiguous 86.2%, 75.9% questions were repeated in multiple years, same areas of curriculum was addressed in 51.7% questions and there was unequal distribution of marks among different topics in 75.9% papers. *Conclusion:* Well-constructed, peer-reviewed question papers meet the educational requirements and are advocated for assessing medical students. To construct the higher level of cognitive domain the faculty has to be well trained.

Keywords: Essay Question; Cognitive Domain; Assessment; Item Writing Flaws.

Background

Assessment is an essential and important component of the medical education. It provides evidence as to, how well the students learning objectives are being achieved and whether the teaching standards are being maintained [1]. Though Many traditional and innovatory assessments methods are used to assess the student learning but still written examination remains as golden standard method to assess the cognitive domain. Question paper is the tool for assessment of written examination. Out of different type of items in the question paper, essay questions plays a major role to assess the understanding and application level of cognitive domain.

Assessment is the important factor that influences and drives student learning. Students perceive the assessment as a dominant factor to motivate and direct their learning. The method of assessment determines the approach of students towards learning. Students' are inclined to espouse a surface approach when assessment emphasis is on just recall of factual knowledge. They tend to adopt a deep approach if assessment demands higher levels of cognitive abilities [2]. Problem-solving skills are an essential component of the medical practitioner's clinical ability and as such must be taught, learned and assessed during training [3].

Framing of questions should be such that assessment become reliable and valid. The Present evaluation system assess only the recall level of cognitive domain. But as medical educators our

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responsibility is to define and provide the skills of the competent physician and to assess whether these skills are acquired or not. As Anatomy is very vast and it is the foundation stone for all clinical subjects, we should cover wider areas in subtopics for assessment. So during framing and planning for the assessment this must be kept in mind.

The present study was taken to analyze the Anatomy question paper item based on modified blooms taxonomy of cognitive level and to estimate the frequency of item writing flaws.

Methodology

The cross sectional study was conducted at Department of Anatomy. 4 years Summative assessment question papers (University examination) were collected and analyzed, (16 question paper and 32 essay questions) for cognitive level and item writing flaws by two assessors separately. Essay questions were analyzed according to modified blooms taxonomy of cognitive levels and by using validated checklist items. Item writing flaws were analyzed using validated checklists. The results were analyzed using SPSS software.

Modified Blooms Taxonomy

Level I: Knowledge, Level II: Comprehension and application, Level III: Problem-solving [3]. The 8 checklists for essay questions and 5 checklists for item writing flaws were prepared and validated. Validation was done by 8 experts from the members of medical education department. The validation was both from internal and external members. After validation the checklists were pilot tested.

Statistical Analyses

Data collected was entered in MS Excel 2010 and analysed using SPSS version 22. Descriptive statistical measures like percentages were applied. The maximum score that a question paper can secure fulfilling all the components of cognitive levels is 13 and minimum score could be 0. Thus 0 to 13 is divided into four quartiles. The question paper that scores Lowest 25% that is zero to 3.25 is categorized as poor, 25 to 50% (3.26 to 6.5) is categorized average, 50 to 75% (6.6 to 9.75) is categorized as good and 75 to 100% (9.75 to 13) is categorized as excellent quality question paper.

Results

Table 1: Essay question analysis

Sl. No	Checklist items	Responses in %
1	Blooms taxonomy Level	100 % from Level I
2	Could the item(Question) be better assessed with a different kind of assessment?	Yes - 27.6 No - 72.4
3	Is the essay question aligned with the intended learning outcome?	No - 22.4 Yes- 77.6
4	Is the essay question too long and should it rather be split up into several relatively short essay questions?	Yes - 24.1 No - 75.9
5	Is the question worded and structured in such a way that it will be clear to the students what they are expected to do?	Yes - 32.9 No - 67.2
6	Is the question structured / semi structured / not structured?	Structured - 67.2 Semi structured - 12.1 Not structured - 20.7
7	Is the question from must know / good to know/ nice to know areas?	Must know - 86.2 Good to know - 10.3 Nice to know - 3.4

Table 2: Item writing flaws

Sl. no	Checklist items	Responses in %
1	Ambiguity	86.2
2	Repitition	75.9
3	Most of the questions from the same area	51.7
4	Not equal distribution of marks in all topics	75.9
5	Lengthy paper	27.6

Among 32 essay questions analyzed, all of them were at level 1 of cognitive level of Bloom Taxonomy. Majority of questions addressed the competency that could be assessed only with essay question, were aligned to learning outcomes, structure and pertaining to must know aspects of curriculum.

Out of 32 essay questions 17.2% were of average, 51.7% were good and 31% were of excellent quality.

In connection with item wise flaws, majority of questions were ambiguous 86.2%, 75.9% questions were repeated in multiple years, same areas of curriculum was addressed in 51.7% questions and there was unequal distribution of marks among different topics in 75.9% papers.

Discussion

Some misconceptions about written assessment may still exist, despite being disproved repeatedly by many scientific studies. Probably the most important misconception is the belief that the format of the question determines what the question actually tests [4]. Any assessment tool has a direct impact on the learning.

The Revised regulations on graduate medical education by Medical Council of India the undergraduate medical education programme is designed with a goal to create an

"Indian Medical Graduate" (IMG) possessing requisite knowledge, skills, attitudes, values and responsiveness, so that he or she may function appropriately and effectively as a physician of first contact of the community while being globally relevant [6]. Assessment of competence of problem-solving ability has been one of the most difficult areas to measure and quantify [6]. This is because it is difficult to produce a higher order cognitive skill questions[7]. The essay question is one of several tools developed to try and assess these skill. The Students usually study to pass the exams so the assessment should be designed in a relevant way[7]. Essay questions and short essay questions are generally given in the exam but lesser studied. The Essay questions allow students more flexibility in their response and reflect their individuality of approach in which interpretative skills are developed. Essay questions allows specific feedback to direct future learning [8]. Essays are ideal for assessing how well students can summarise, hypothesise, find relations, and apply known procedures to new situations. They can also provide an insight into different aspects of writing ability and the ability to process information [4].

Edward in their study on analysis of modified essay questions in the 2005 paper 51% of the questions tested factual recall (Bloom level I), 47% tested data interpretation (Bloom level II) and only 2% tested critical evaluation. The pattern was similar for the 2006 paper with 54% testing Bloom level I cognitive skills and the remainder (46%) testing Bloom level II [3].

Another study on analysis of modified essay questions showed that 39.4% of questions testing level I, 20.25 on level II and 40.4% are on level III of blooms level of cognitive domain[9]. In another study 83.33% of SEQs was at recall level while remaining 16.67% were assessing interpretation of data. But in the present study all the essay questions (100%, Table 1) were testing Bloom level I cognitive skills.

It is evident from the questions paper analysis that different subdivisions of anatomy are usually not given proper weightage in the anatomy written examinations [10]. Adequate coverage of the course content is necessary for the validity of assessment [11]. Weightage to the content areas is a delicate issue on which even the experts often differ in opinion and the weightage of various topics depended mainly on the examiners own judgment [12]. In the present study 75.9% (Table 2)of papers had unequal distribution of marks. Garg R in their study found that different subdivisions of Anatomy are usually not given proper weightage in the Anatomy written examinations and there are some aspects which are usually covered less than required [10]. Some subdivisions of Anatomy remained uncovered in some question papers. For example, questions from Genetics were found in the question papers of only four sessions out of fifteen sessions examined. There were some sessions where there was complete absence of questions from Clinical Anatomy and from some particular areas of Regional Anatomy[13].

Few studies demonstrate that some faculties are unable to frame questions and the effects of this poor examination system reflecting in students' performance[14]. It is quite understandable that conduction of a proper assessment is not only dependent on the cognitive aspect of question, but there are so many factors which play a role like, reliability, content and construction validity, financial and human resources[9]. In the present study most of the significant results like ambiguity, repetition and unequal distribution of marks in the item writing flaws could be mostly attributed to lack of awareness, commitment from the faculty, not giving importance to blue printing and insufficient training of the faculty.

Conclusion

In the present study all the essay questions were of level I of Blooms cognitive domain. In written examinations But to produce a competent physician we need to assess the higher level like understanding and application level of cognitive domain. Though most of the essay questions were of good quality and structured but they were testing only just recall of knowledge. Lot of ambiguity, repetition and no proper weightage to all the divisions of Anatomy. Probably the flawed items are due to lack of training to the faculty. As the curriculum is moving towards competency based even the assessment should be structured in such a way that it should align with learning objectives. Faculty should be encouraged and trained to construct an essay questions for higher order of cognitive level. Through the faculty development programs these item writing flaws could be reduced to minimum.

Key Messages

Conscious awareness would avoid item writing flaws and faculty training would mould faculty to develop higher cognitive level essay questions.

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Dermatoglyphic Study In Diabetes Mellitus

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Abstract

Dermatoglyphics is the science that studies the carvings over the volar aspect of skin over palms, soles & fingers. (Derma = skin, glyphics = carve) The markings are due to underlying interlocking patterns of dermal papillae & overlying corresponding epidermal ridges. These features were found to be permanent variables and were inherited by polygenic system with individual gene contributing a small additive effect. Dermatoglyphic investigation has been undertaken to ascertain the reliability of dermatoglyphics as a predictive diagnostic tool for diabetes.

The present research aims to primarily study the various dermatoglyphic patterns in the patients with Diabetes Mellitus and compare these statistically with the dermatoglyphic patterns innon diabetic individuals. The present study was carried out on 164 (96 male and 68 female) clinically diagnosed patients of diabetes mellitus and165 healthy controls (111 males and 54 females) were studied for comparison. Palmar prints were obtained in all the patients and controls and the dermatoglyphic patterns were analyzed using statistical considerations.Analysis of fingertip pattern like arch, radial loop, ulnar loop and whorls did not show any significant difference. TFRC, a-b ridge count, a-t-d angle and number of triradiirevealed increased frequency in the diabetic cases as compared to controls.

Keywords*:* Arch***;*** Dermatoglyphics; Diabetes Mellitus; Radial Loop; Ulnar Loop; Whorl.

Abbreviations

ATD - 'A' as tri radius found below the index finger, 'T' as axial tri radius above the wrist crease, 'D' as tri radius present below the little finger *TFRC*: Total finger ridge count.

Introduction

Diabetes mellitus comprises a group of common metabolic disorders which is characterized by hyperglycemia. Several distinct types of diabetes mellitus exist & are caused by complex interaction of genetics, environmental factors & life style choices. Diabetes affects an estimated 16 million people in United States, as many as half of whom are undiagnosed [1]. Worldwide more than 140 million people suffer from diabetes making this one of the most common non-communicable diseases [2]. Prevalence of diabetes has risen dramatically in past two decades. The number of affected individuals with diabetes is expected to double by 2025 & countries with largest number of diabetes are India, China & United States [1].

Major genes that predispose to this disorder have yet to be identified, but it is clear that the disease is polygenic & multifactorial.Thedermatoglyphic pattern is determined by expression of multiple genes & individual gene contributing to small additive effect. Once formed in intrauterine life around 12th to 16th week these dermatoglyphic patterns are not altered thereafter and they form the basis of individual identity, as they are unique to every individual [3].

Dermatoglyphics is one of the advanced branches of medical sciences, where the dermal ridge patterns are studied & used in prediction of genetic disorders for diagnosis of twins, questioned paternity & other hereditary disorders. Some diseases are known to be caused by abnormal genes. Whenever there is any

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abnormality in the genetic makeup of parents, it is inherited by the children & reflected in the dermatoglyphics pattern. Hence the study of dermatoglyphics proved to be very useful in predicting the hereditary diseases in patients.

The present study was designed to compare the dermatoglyphic patterns of patients suffering from diabetes mellitus with normal individuals. It was also designed to compare it with previous studies and to know which quantitative and/or qualitative dermatoglyphic parameters show variation with respect to previous studies.

Materials and Methods

The present study was carried out in Endocrinology OPD in our tertiary health care institute on 164 patients of both type 1 and type 2 diabetes mellitus confirmed by clinical and laboratory assessment. The control group for study consisted of 165 subjects.

Cases and Controls were selected after taking a brief history for ruling out any known genetic disorder, any congenital disease or fingerprint or other dermatoglyphic abnormalities.

The purpose of study was explained to both cases and controls. Then proper information regarding the procedure of recording prints was given to members of both groups who agreed for the study. After their written consent the palm and finger prints were taken. Personal data of subject (name, age, address etc.) and history was recorded in case record form.

Ink method was used as described by Cummins & Midlow[4]which requires ink slab, inverted 'T' shaped pad, Kore's duplicating ink, white paper, magnifying lens, protractor, scale, soap & pencil.Hands were thoroughly washed with soap before taking prints.Then requisite amount of ink was placed on the ink slab & inverted 'T' shaped pad was soaked in it.The ink was evenly spread on the ink slab by light dusting. Then fingers were rolled laterally on the slabon which ink was transferred. Then they were placed on a white paper with one lateral edge & then rolled over in opposite direction. To take palm print palm was lightly dusted with the same 'T' pad. The palm was then kept on white paper & firm pressure was given on the center of the dorsum of hand &interdigital areas.Thus dermatoglyphic patterns were recorded & studied with magnifying lens.

Results

In this study 164 cases & 165 controls were analyzed for their dermatoglyphic patterns.

There were 207 males (96 diabetic & 111 controls) and 122 females (68 diabetic & 54 controls) in both diabetic & non-diabetic group. Qualitative parameters {fingertip patterns – arches, radial & ulnar loops, whorls & quantitative parameters [TFRC (total finger ridge count),'a-t-d' angle, a-b ridge count & no. of triradii were studied &analysed using statistical methods. Statistically significant parameters were noted and tabulated.

From Table 1 it is clear that fingertip pattern like arch, radial loop, ulnar loop and whorls in diabetic cases and controls is not significant statistically.

From Tablen 2 it is clear that females had more no.of arches as compared to males in both diabetic cases and controls (P value =0.005,Chi square test significant). Radial loop pattern does not show any difference between male versus female in both diabetic and control subjects. Also it has been observed that males had more no.of ulnar loops (P value =0.009,Chi square test significant) and whorls(P value =0.0360,Chi square test significant) as compared to females in both diabetic cases and controls.

Quantitative parameters like TFRC, a-t-d angle, a-b ridge count and no. of triradii were analysed in diabetic case and controls. It was found that the mean TFRC in diabetic cases was 68.71 with standard deviation of 11.810 and mean TFRC in controls was 63.76 with standard deviation of 10.984 and was statistically significant (Chi square test).

Analysis of a-t-d angle revealed that a-t-d angle was significantly increased in diabetic patients (DM) than non diabetic control (CT) subjects. (p value <0.0001, unpaired 't' test).

Further analysis of males & females revealed that diabetic patients (DM) had significantly more mean a-t-d angle than non-diabetic control (CT) subjects. (P value <0.0001, Kruskal Wallis test for both).

Analysis of a-b ridge count revealed that there were significantly more number of a-b ridges in diabetic patients (DM) as compared to non-diabetic control (CT) subjects (P value <0.0001, Kruskal Wallis Test).

Analysis of number of triradii revealed that diabetic patients (DM) had significantly more number of triradii than in non-diabetic control (CT) subjects. (P value <0.0001, Kruskal Wallis test).

Similarly further sub-group analysis of mean number of triradii revealed that diabetic males & females had significantly more number of triradii than non diabetic males & females. (P value < 0.0001, Kruskal Wallis test).

Table 1: Fingertip pattern distribution in diabetic cases and controls

Pattern	DM			Controls			P value	Test of significance Chi square
	Rt. hand	Lt.hand	Rt+Lt.	Rt. hand	Lt.hand	Rt+Lt.		
Arch	163	114	277	200	171	371	0.210	NS
RL	166	145	311	218	238	456	0.129	NS
UL	167	218	385	250	282	532	0.279	NS
Whorl	324	341	665	159	134	293	0.113	NS

Rt-Right, Lt.-Left, NS-Not Significant, RL-Radial loop, UL-Ulnar loop

Table 2: Analysis of fingertip pattern as per sex, diabetic status and hand

Sr. No.	Fingertip pattern	Sex	Diabetic cases		Controls		Total	P value	Test of Significance
			Rt. hand	Lt. hand	Rt. hand	Lt. hand			
1	Arch	M	64	49	61	51	225	0.005	Chi sqare test
		F	99	65	139	120	423		
2	Radial loop	M	100	89	143	163	495	0.71	Chi sqare test
		F	66	56	75	75	272		
3	Ulnar loop	M	94	125	177	189	585	0.009	Chi sqare test
		F	73	93	83	93	342		
4	Whorl	M	187	201	108	84	580	0.0360	Chi sqare test
		F	137	140	51	50	378		

Rt-Right, Lt.-Left

Table 3: Analysis of quantitative parameters such as a-t-d angle, a-b ridge count and no. of triradii

Sr. No.	Fingertip pattern	Sex	Diabetes		Controls		P value	Test of Significance
			Rt. hand	Lt. hand	Rt. hand	Lt. hand		
1	a-t-d angle	M	55.54 ± 1.18	59.27 ± 0.85	45.30 ± 0.63	44.37 ± 0.48	<0.0001	Kruskal Wallis test
		F	57.46 ± 1.18	57.94 ± 1.14	44.43 ± 1.04	45.48 ± 0.60	<0.0001	Kruskal Wallis test
		Mean	56.18 ± 0.85	58.72 ± 0.69	45.01 ± 0.54	44.73 ± 0.38	<0.0001	Unpaired t test
2	a-b ridge count	M	33.89 ± 0.71	30.57 ± 0.74	28.88 ± 0.64	29.92 ± 0.61	<0.0001	Kruskal Wallis test
		F	33.47 ± 0.80	31.00 ± 0.86	28.20 ± 0.88	30.46 ± 0.93	<0.0001	Kruskal Wallis test
		Mean	33.71 ± 0.53	30.75 ± 0.56	28.66 ± 0.52	30.10 ± 0.51	<0.0001	Kruskal Wallis test
3	No. of triradii	M	6.01 ± 0.08	6.17 ± 0.06	5.22 ± 0.04	5.08 ± 0.03	<0.0001	Kruskal Wallis test
		F	6.21 ± 0.09	6.13 ± 0.09	5.24 ± 0.07	5.06 ± 0.03	<0.0001	Kruskal Wallis test
		Mean	6.10 ± 0.06	6.15 ± 0.05	5.22 ± 0.04	5.07 ± 0.02	<0.0001	Kruskal Wallis test

Table 4: Comparison of dermatoglyphic parameters

Study	Arch	UL	RL	Whorl	TFRC	a-b ridge	a-t-d angle	No. of triradii
Verbove et al	↑ DF	---	NS	↓ DF	-----	↓	--	↑ DF
Sant et al	↑ DM	↓DM &DF	↓ DM	↑ DM &DF	-----	---	----	----
Vera et al	↑ DF	---	NS	----	↓	----	-----	↑
Bets et al	↑ DM	↓ DF	↓	---	----	----	-----	----
Ravindranath et al	↑ DM	↑ DM &DF	↓ DM & DF	↓ DM &DF	↓ DM & DF	---	-----	----
Panda et al	↑ DM & DF	↑	↑	↓	↑	---	----	-----
Rajanigandha et al	NS	NS	NS	NS	-----	NS	↑	↑
Mandascue et al	NS	NS	NS	NS	-------	NS	↓ DM (RH)	---
Batra et al	--------	----	---	-----	↑ DM &DF	-----	----	-----
Ziegler et al	-------	----	----	----	------	↓	-----	↑
Iqbal et al	-----	----	---	-----	↑ DM	-----	-----	------
Sarthak et al	↑ DM	---	-----	↑ DM &DF	↓ DM & DF	-----	-----	-----
Burutepushpa et al	↑ DM &DF (LH)	↑ DM & DF (LH)	NS	↓ DM &DF	↓ DM &DF	----	-----	----
Sharma M et al	NS	NS	NS	NS	↑	NS	↑	----
Ahuja et al	-----	------	-----	-----	↑	-----	-----	-----
Present study	↑ DF	NS	↑ DM	↑ DM	↑	↑	↑ DM &DF	↑

DM-Diabetic Male, DF-Diabetic Female,'!-increased, "!-decreased, NS-Not Significant,LH-left hand, RH-right hand

Discussion

In the present study, Qualitative parameters {fingertip patterns – arches, radial & ulnar loops, whorls in diabetic cases and controls did not show any statistical significant difference and hence it can be concluded that distribution of qualitative fingertip pattern is same in both diabetic cases and controls.Verboveet al [5] and Vera et al [6] found increased incidence of arch pattern in female diabetics only. Sant et al [7] , Bets et al [8] Ravindranath et al [6] and Sarthak et al [10] found increased incidence of arch pattern in male diabetics only whereas Burute et al [11] found increased arch pattern in male diabetics and female diabetics in left hand only. Rajanigandhaet al [12], Mandascue et al [13] and Sharma et al [14] did not show any significant difference in arch pattern. Present study showed females had more no. of arches as compared to males in both diabetic cases and controls. Sant et al [7], Bets et al [8] found decreased incidence of UL, Ravindranath et al [9], Panda et al [15] and Burute et al [11] found increased incidence of UL whereas UL pattern was not significant in Rajanigandha et al [12], Mandascue et al [13] and Sharma et al [14]. In the present study males had more no.of ulnar loops as compared to females in both diabetic cases and controls. RL pattern was decreased in Sant et al [7] , Bets et al [8] and Ravindranath et al [9] and was found increased in Panda et al [15] whereas it was not significant in Rajanigandha et al [12], Mandascue et al [13], Burute et al [11] and Sharma et al [14] and in the present study also. Whorl pattern was found decreased in the study of Verboveet al [5], Ravindranath et al [9], Panda et al [15], Burute et al [11] and found increased in Sant et al [7], Sarthak et al [10]. Whorl pattern was not significant in Rajanigandhaet al [12], Mandascue et al [13], Sharma et al [14]. In the present study males had more no.of whorls as compared to females in both diabetic cases and controls.

Quantitative fingertip pattern TFRC was found decreased in the study done by Vera et al [6], Ravindranath et al [9], Sarthak et al [10], Burute et al [11] and was increased in study done by Panda et al [15], Batra et al [16] , Iqbal et al [17], Sharma et al [14] and Ahuja et al [18] and also in the present study, a-b ridge count was found decreased in the study of Verbove et al [5], Ziegler et al [19] and was found increased in the present study. A-t-d angle was found increased in the study of Rajanigandha et al [12], Burute et al [11] and in the present study but was found decreased in Mandascue et al [13]. It was oserved that diabetic cases had prescence of additional axial triradius as compared to controls and was seen in the study of Verbove et al [5], Vera et al [6], Rajanigandha et al [12], Batra et al [16] and in the present study.

Conclusion

So from the above discussion it can be concluded that qualitative fingertip parameters like arch, radial loop, ulnar loop, whorl and the quantitative parameters like total finger ridge count (TFRC) and a-b ridge count show variations with previous studies and hence not useful for pre detection of diabetes. The only parameters which does not show variation with previous studies are 'a-t-d' angle, number of triradii. Hence it can be concluded that these parameters can be useful for pre detection of diabetes by dermatoglyphic method and to identify the persons who are at risk,but needs to be studied in a larger population to be used as a diagnostic tool.

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Program Evaluation

Col Aseem Tandon*, Col Sushil Kumar**

Abstract

Faculty development programs in medical education have received a shot in the arm after the MCI by the MCI Regulations on Graduate Medical Education, 1997, made it mandatory for all medical colleges to establish Medical Education Units (MEUs) or departments in order to enable faculty members to avail modern education technology for teaching. However, there is need for a systematic approach to comprehensively evaluate the effectiveness and the impact of these programs. The lessons learnt from such evaluation can then be suitably applied to increase the effectiveness of the program. This paper addresses this issue applied to an on-going faculty development program in medical teaching technology at the Armed Forces Medical College, (AFMC), Pune, India.

Keywords: Medical Education; Faculty Development Program.

Introduction

Faculty development programs (FDPs) are especially important in adapting faculty members to their changing roles in initiating and setting the directions for curricular changes. These programs can be a powerful tool to constitute a positive institutional climate and can range from basic orientation programs for new faculty members to postgraduate medical education programs for health professionals. Overall, the aim of all these training programs is to support medical educators in adapting to changing missions of teaching and to enhance the efficiency and performance of their teaching skills while improving work satisfaction and teaching confidence by developing good teachers (1, 2, 3, 4). It has been suggested that comprehensive FDPs should have four development components: professional, instructional, leadership, and organizational (5, 6). According to a systematic review, the majority of FDPs include workshops, seminar series, short courses, and longitudinal programs (7). Key features of effective faculty development give a high priority to experiential learning, provision of feedback, effective peer and colleague relationships, well-designed interventions in accordance with the principles of adult learning theory, and the use of diverse teaching and learning methods (7).

In light of recent developments in medical education, several medical colleges in India under their respective health universities have accepted a certificate in training skills as a criterion for academic promotion as is being followed in other countries (8). Also Faculty development programs in medical education have received impetus after the MCI by the MCI Regulations on Graduate Medical Education, 1997, made it mandatory for all medical colleges to establish Medical Education Units (MEUs) or departments in order to enable faculty members to avail modern education technology for teaching.

The faculty training program in Armed Forces Medical College, Pune, India was designed to enable faculty members to improve their skills in teaching and assessment methods. For this purpose, "Medical Teacher Training Programs in education science and technology" (MTTP) courses are organized twice a year.

The Department of Medical education has been conducting MTTP courses since 1993 and these are focused on major themes, such as identifying learning objectives, identifying the principles of adult learning, creating and maintaining a positive learning

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environment, developing and using audiovisual training tools and equipment effectively, using interactive teaching techniques in both large and small groups, making an effective demonstration, and coaching and developing competency-based skills, learning, and assessment guides comparison of the assessment methods according to objectivity, validity, and specificity; preparing and analyzing multiple-choice and essay questions; advantages and disadvantages of oral examinations and how to prepare a structured oral examination; and the use of clinical skills and methods for assessing oral examinations.. The course takes 3 days (total: 24 h) and is conducted in an interactive way, consisting of exercises for small groups with plenary discussions and brief expository lectures. On day 2 of the course, there is a microteaching session in which participants were asked to demonstrate the teaching techniques they had acquired in a presentation of their own design.

The instructors/facilitators of the courses were volunteer faculty members from the Departments of Medical Education, Anatomy, Physiology, Biochemistry and other Para clinical and clinical departments who had a specific interest in medical education and completed the required courses to become facilitators, willing to devote part of their professional time to faculty development in AFMC. This article was written to evaluate the FDP by these instructors.

Studies based on feedback of the FDPs have a unique role in guiding faculty development, since they demonstrate the impact of the FDP upon the educational experiences of the teachers, resulting in the improvement of their teaching practices [9]. The use of self-assessment as a tool enables the participants to make a conceptual integration of knowledge, skill, and attitude [10].

In general, FDPs are evaluated with diverse assessment instruments, such as pre-test/post-test, retrospective self-assessment, and independent performance ratings [7, 11]. Another type of program has been analyzed with context, input, process, and product evaluations [7]. Some studies [12,13] of faculty training programs have evaluated the opinions of participants about the efficiency of the training program. Other studies [14,15] aimed to elucidate the educational impact of the newly acquired knowledge and skills upon individual and occupational performances in the professional life of the participants.

The present study was planned as a part of the program evaluation activity. In our study we evaluated the impact of the FDP on the participants in terms of gains in knowledge, skills at the end of the program by conducting a pre and a post-test. This is thought to be important so that course content and teaching methods can be matched to faculty needs in different disciplines and at different professional levels.

Materials and Methods

The study was carried out in AFMC over a period of four years from 2011 to 2014. A total of 183

Table 1: Post workshop questionnaire

Questions	Yes	No	Not sure
1. Were the objectives of the workshop largely achieved?			
2. Do you ? nd the workshop useful for your professional activities?			
3. Did the workshop elicit your active participation?			
4. Were the Audio-Visual arrangements made during the workshop satisfactory?			
5. Do you think you will be able to implement the techniques learnt during the workshop in your practice?			
6. Were the arrangements made during the workshop satisfactory?			
7. Do you recommen d the organization of similar activity for the bene? t of your colleagues?			
8. Does the program have a balance of Theory and Practical?	Too much of Theory	Too much of practical	Optimum Theory & Practical
9. Was the time estimation satisfactory?	Program was Too tight	Program was Too relaxed	Program was Optimum
Mention sessions which were Especially found useful:			
Mention sessions which, you think, are not necessary:			

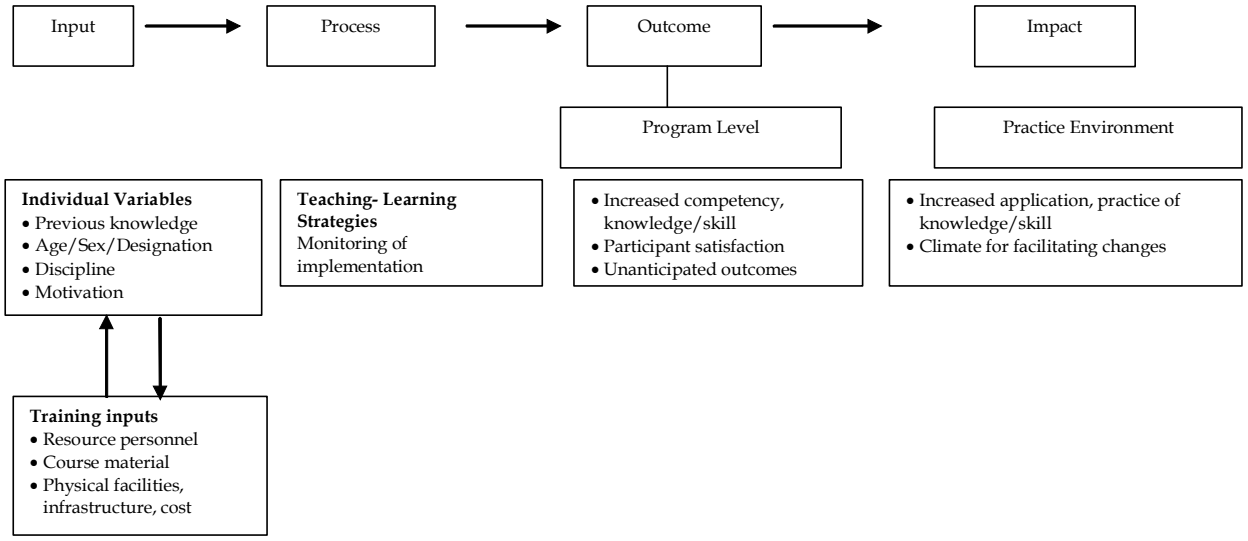
Dear Participant,
The purpose of this questionnaire is to obtain your feedback on the effectiveness of the sessions which you underwent during the workshop. Your response will help us in improving such activity in future.
Any other Comments/Suggestions

participants spread over eight courses during this period were subjected to this evaluation. Participants of the FDP were administered a pre-test (launch pad) at the beginning of the course and a post-test (performance assessment) at the end of the course. The pre test was conducted on the first day of the programme immediately after the Opening Address. A post test comprising the same questions which were asked during the pre test (Performance assessment) was held on the penultimate day in order to assess the success of the programme In addition a *Program Evaluation Questionnaire* was administered to the participants on the last day of the course to elicit their opinion on various aspects dealing with the course (Table 1).

Results and Discussion

A program can be conceptualized as a system of interrelated components working towards the goal of producing desirable outcome, which in turn, are expected to make an impact on the practice of the participants (Table 2). The program in medical education technology is an *intervention* which is expected to produce some desirable outcome, viz., increase in the competency of participants, which in turn, would influence their day-today educational practice.

Table 2: Program in Medical Education Technology: A conceptual model



Inputs

These refer to all kinds of resources, including physical resources, technical, financial and human resources which contribute to the program. The entry behaviour of the participants (their previous knowledge, skills, disciplinary affiliation and motivation) constitutes a major input variable. Other inputs are: the quality of instructional support by the Resource persons, the relevance and the quality of the course material and infrastructure variables, viz., venue, physical facilities, audio-visual equipment, seating plan, time and cost involved in each item.

Process

This refers to a set of activities in which the inputs are utilized in pursuit of the results expected from the program. It includes implementation, monitoring and identification of the strengths and limitations, so that corrective action can be taken to improve the program. It also includes the teaching-learning strategies employed in the program including the learning climate.

Outcomes

Outcomes refer to the results obtained at the end of the program as well as after the program i.e., at the practice setting of the participants. Outcomes can be operationalized in terms of a) gains made by the participants in terms of knowledge, skills at the end of the program; b) change in the attitude of participants, and their satisfaction level; c) unanticipated outcome of the program.

Impact

Impact refers to the changes taking place in the relevant behaviour and practice of the participants which can be attributed to the intervention i.e., program. Impact measurement is done usually after a period of six months or more.

Outcome Evaluation

The main outcomes expected at the end of the program are: increase in the knowledge and skills of

the participants, increased application of educational technology, and development of educational leadership.

Pre-Test/Post-Test

The participants were administered a pre—test (launch pad) at the beginning of the program and a post—test (performance assessment) at the end to assess the relative improvement in their performance. These tests were essentially knowledge based and the comparison of result obtained is as shown in Table 3.

In the pre-test only ten participants (0.054%) were able to score above 50% marks (possibly because of some pre course training). Majority i.e. 137 (74.86%) scored less than 33% and the remainder 36 (19.67%) scored between 33-50% revealing a general low level of knowledge, awareness and understanding of commonly used terms in medical education and therefore a need to sensitize the participants about modern methods of teaching and the science and art of medical education.

After the conduct of various sessions during the program a post test (Performance assessment) comprising the same questions which were asked during the pre-test was held on the penultimate day in order to assess the success of the program. This revealed a marked improvement in the scores of all participants as shown in Table 3. Forty four participants (24.04%) secured more than 70% marks, 134 (73.22%) got between 50 – 70% and only 5 participants (0.027%) scored less than 50% marks indicating the effectiveness of the program.

In addition A *Program Evaluation Questionnaire* was administered to the participants on the last day of the workshop to elicit their opinion on various aspects dealing with the process (Table 1). The participants were encouraged to give their free and frank opinions, as their responses are held anonymous. The participants were also encouraged to give their "Informal" feedback during tea/lunch breaks, or any other free time found in between the deliberations. The valedictory session of the course includes a slot for the participants to express their views on the workshop. The data obtained from these will be compiled, analysed and utilised for a comprehensive evaluation of the program subsequently.

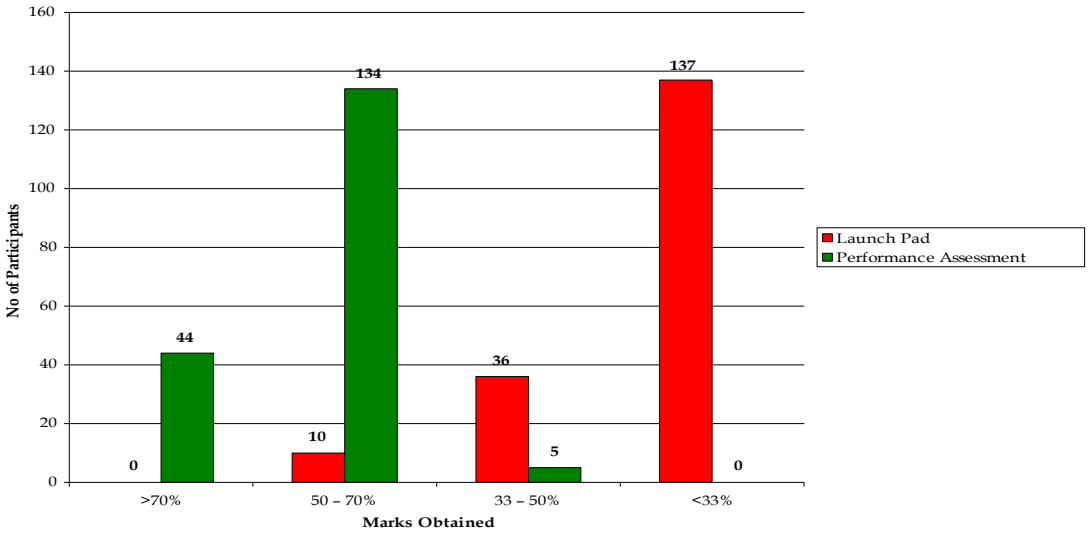


Fig. 1: Pre and post test result

Conclusion

As regards outcome evaluation, the present approach (e.g. Pre test, post test) is inadequate to measure gains in the competence, especially the skill development. In addition, "unintended''* effects are totally overlooked. Some of the unintended effects reported by the participants are: increased utilization of media services, positive interpersonal relation amongst participants, and decrease in resistance to change. Resistance to change is inherent in any organization. Resistance is linked with lack of awareness or involvement in a given activity. The participants of workshops by virtue of clear perception of the advantages of educational strategies are likely to act as "change agents".

The lessons learnt after evaluation point towards adopting a comprehensive model to evaluate the inputs, the process, the outcome and the impact, on short term and long term basis. These strategies are bound to be useful in strengthening future programs conducted by the department. At the same time, they are likely to provide a new insight into the issue of evaluation of similar programs conducted by other agencies under similar circumstances.

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Original Article

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Study of Incidence in Number of Renal Hilar Structures [Artery, Vein, Pelvis] in Human Cadaveric Kidney

Uday Kumar*, Ratna Prabha*, Vishal Salve**

Abstract

Background and Aims: The advent of more conservative methods in the renal surgery has necessitated a more precise knowledge of renal vascularisation at the renal hilum and it has its importance in partial and total nephrectomy and also in renal transplantation surgeries. This study is mainly aiming at the incidence in the number of renal hilar structures [renal artery, vein and pelvis]. *Material and Methods:* Totally 84 kidneys were studied in the present work by blunt dissection method. These 84 kidneys were collected from department of Anatomy, Navodaya medical college and hospital, some were formalin stored and some freshly dissected from cadavers during the routine dissection classes of medical students. The incidence of no. of renal artery .vein and pelvis were observed. *Results:* Out of 84 kidneys studied, single renal artery was seen in 72 specimens and 12[14.28%] specimens showed double renal arteries coming separately from abdominal aorta and entering separately at the upper part and lower part of hilum. Double renal veins were seen in 3 specimens [3.57%]. These renal veins were coming out of hilum and passing in front of renal artery and entered the inferior venecava. Only one kidney [1.19%] showed double pelvis which was coming out of kidney separately from posterior upper and lower part of hilum and joined just before opening into the urinary bladder. *Conclusion:* The knowledge of such variations in number of structures is important in carrying out renal surgeries.

Keywords: Kidney; Number; Renal Artery; Vein; Pelvis.

Introduction

Kidney is the pair of bean shaped excretory organs situated retroperitoneal in the lumbar region on either side of vertebral. The kidney has two borders; Lateral border which is convex and medial border is concave and shows a deep vertical fissure known as hilum, which is bounded by anterior and posterior lips. Here is the passage of renal vessels, pelvis of ureter, lymphatic's and nerves [1]. Normally we have single renal artery, vein and pelvis at the hilum and their positions from anterior to posterior are renal vein, renal artery and renal pelvis in that order.

The present work was undergone to know the incidence of any extra renal vessels and pelvis. This study can improve the safety of newer percutaneus intrarenal access by intact as many renal vessels as possible during the percutaneus puncture, thus preventing the through and through puncturing of artery and collecting system. The increase in no. of renal vessels may compress the renal pelvis thus creating complications like hydronephrosis.

In 70% individuals there is a single renal artery to each kidney [1]. The artery divides into anterior and posterior division near the hilum. And there is single renal vein lying anteriorly extends from hilum to inferior venecava, the left is longer than right [2].

The upper end of ureter expands to form the pelvis of kidney. The single renal pelvis comes out through the posterior part of the hilum posterior to renal vessels [1].

In 1552, Eustachio's [2] described a case of multiple renal arteries, he also made the first copper plate engravings illustrating renal artery variations. In 1714 Lanciisi [3] published the engravings with commentary and referred to the variations as a "lusus nature" or sport of nature. In 1901, Harvey [4] reported a case of bilateral multiple renal arteries and

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renal veins. Nation [5] in his series of autopsy studies of 16000 cases found the following types of duplication of ureter- Unilateral complete duplication of ureter in 78 cases, Unilateral partial duplication in 99 cases, bilateral complete duplication in 35 cases and partial bilateral duplication in 19 cases. Prasad et al [6] reported association of a bifid ureter with presence of unilateral pulmonary hypoplasia likewise Gunduz et al [17] found a duplex ureter associated with presence of Golts syndrome. Pushpa Dhar et al [8] in their routine dissection revealed 2 right renal veins where artery was sandwiched between the two renal veins and another study by same authors with corrosion cast method showed multiple renal veins were common on the right side . So like this many authors have studied only variation of single structures at the renal hilum. Here my study is regarding variation in no. of renal artery, vein and pelvis and this study is useful information for urosurgeons, radiologists and academic importance to Anatomy teachers.

Material and Methods

The present work was conducted in department of Anatomy at Navodaya medical college and hospital. Totally 84 kidneys [42 pairs] was collected from the department. All the kidneys were cleaned by doing the blunt dissection method by using forceps and scissors. The kidneys were looked for fullness of specimen, any cut kidney specimens were excluded from the study. Finally selected kidney specimens were numbered with number plates and observed for the number of renal vessels and pelvis at the hilum. The kidney showing the double renal artery, renal vein and pelvis were coloured [red for artery, blue for vein and yellow for pelvis] and photographed. Relevant data were recorded and analysed statistically (manually).

Results

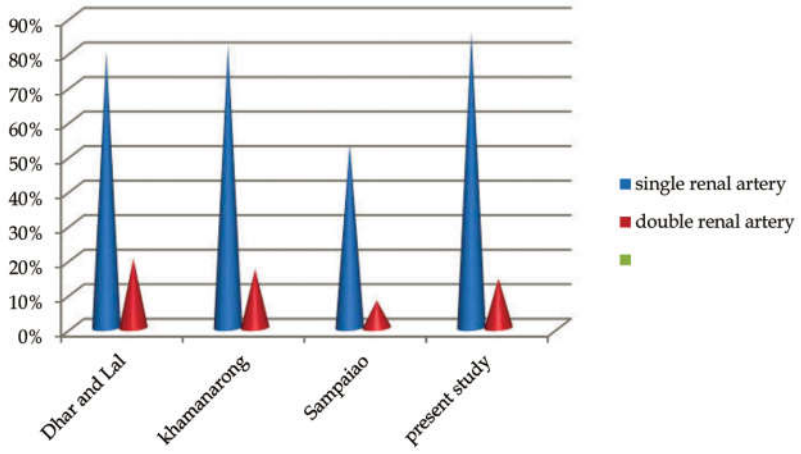
Out of 84 kidney specimens, 12 specimens [14.28%] showed double renal artery, which were arising separately from abdominal aorta and entered the renal hilum at the upper and lower part of the hilum [Fig1]. The two renal arteries were named as upper and lower renal artery [Table No. 1 and Graph No.1]

Out of 84 kidneys , 3 specimens[3.57%] showed double renal veins which were coming out of renal hilum at the upper and lower part of it [Fig 2]. These veins were ending separately into inferior venacava. Double renal veins were seen only on the right side. In the same specimens the left renal vein was single [Table No. 2 and Graph No. 2].

Out of 84 kidneys, only one kidney [1.19%] showed duplex pelvis which continued as double ureters , but both of them joined and entered the urinary bladder with single opening [Fig 3]. The duplex was seen on the left side of renal pelvis [Table No. 3 and Graph No. 3].

Table 1: incidence of single and double renal artery in present study and other authors

Sl. no	Authors	Single renal artery[%]	Double renal artery[%]
1.	Dhar and Lal [8]	80	20
2	Khamanarong [33]	82	17
3	Sampaiao F J [34]	53.3	7.9
4.	Present study	85.71	14.28



Graph 1: showing incidence of single and double renal artery in present and other studies

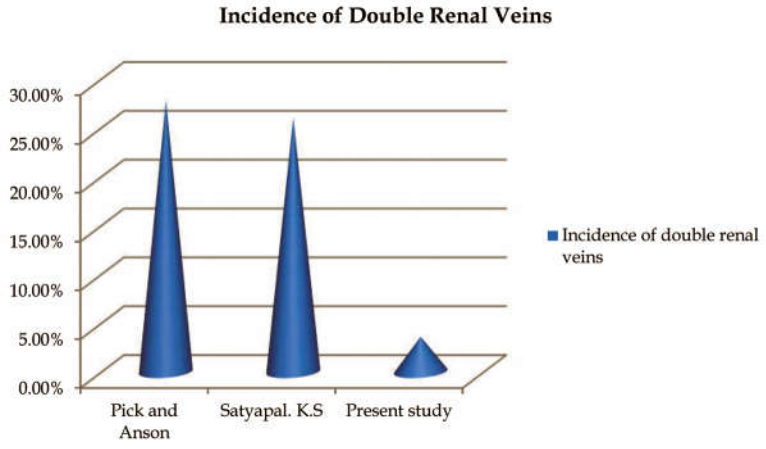
Table 2: Incidence of double renal veins and comparison with other authors

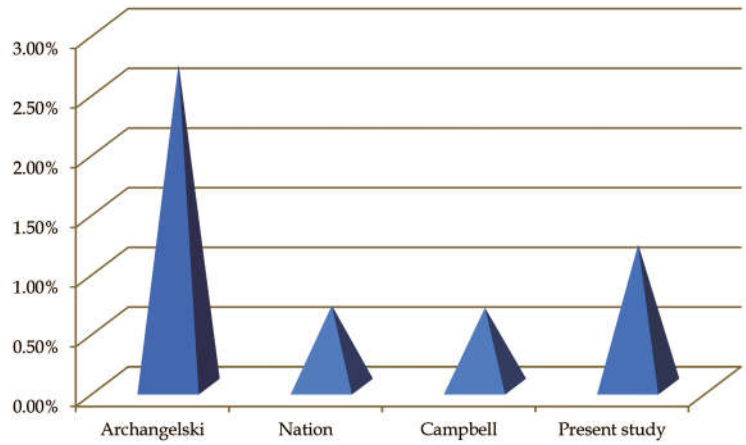
Sl. No.	Authors	Incidence of Double Renal Veins
1.	Pick and Anson [25]	27.8%
2.	Satyapal. K.S [35]	26%
3.	Present study	3.57%

Table 3: Incidence of duplication of pelvis in present study and its comparison with other authors

Sl. No.	Authors	Incidence of Duplication [%]
1.	Archangelski [28]	2.7%
2	Nation [5]	0.68%
3.	Campbell [32]	0.66%
4.	Present study	1.19%

Graph 2:





Graph 3: incidence of duplication of pelvis in present study and its comparison with other authors

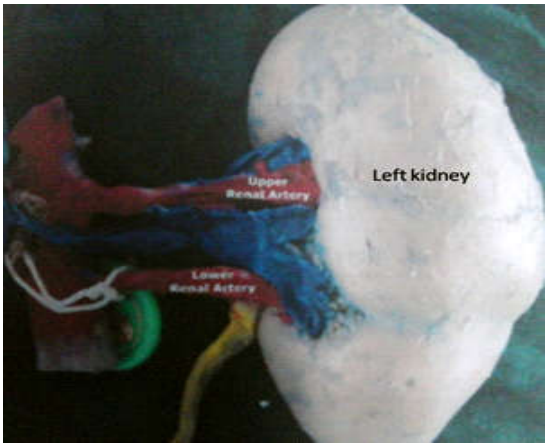


Fig. 1: left kidney showing double renal arteries

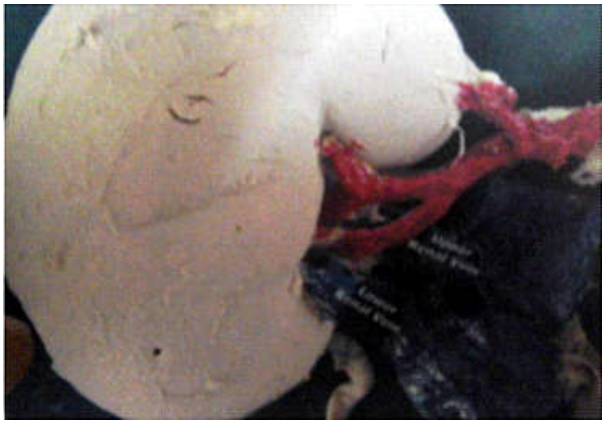


Fig. 2: right kidney showing upper and lower right renal veins

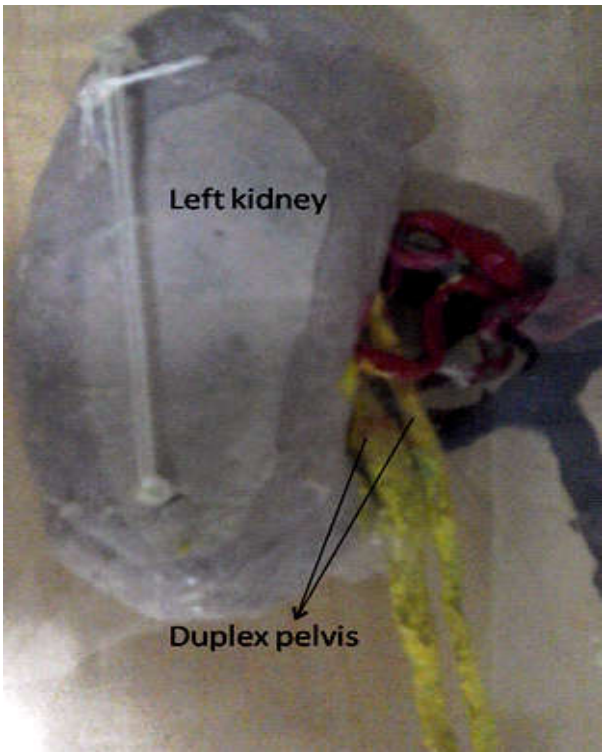


Fig. 3: left kidney showing duplex pelvis[left kidney posterior view]

Discussion

Kidney is the pair of excretory organs present retroperitoneally in paravertebral position at the lumbar region. The kidney has single renal artery, renal vein and pelvis at the hilum in 70% of individuals [1]. Many earlier authors have reported the supernumerary vessels and duplex,triple pelvis which were because of the insults or disturbance during the development of kidneys and its vasculature. The renal arteries originate from the abdominal aorta and account for 20% of cardiac output to the kidney [1]. The renal vascular segmentation was discovered by john hunter [9] in 1794, but detailed account was given in 1950's by F T Graves [10] corrosion cast method. There are five defined arterial segments: apical, superior, middle, inferior and the posterior. In 1920 , an extensive study done by Daniel N Eisendranath [11] in different series of studies found—5 out of 124 kidneys had double renal arteries. Riichiro Toda [12] and his colleagues operated upon a 72 old man with an abdominal aortic aneurysm and found double left renal vein forming a ring around aorta. Another case reported by Bayramoglu et al [13] which showed bilateral double renal arteries in a 68 year year male cadaver. In 2005 Verma et al [14] reported a case of double renal veins with double testicular veins. The two renal veins draining separately into IVC. Another study done in 2005 by R.M.P Fernandes [15] and his colleagues found 3 renal veins draining the right kidney, they named it as superior right renal vein [SRRV], middle right renal vein [MRRV], inferior right renal vein [IRRV] according to the location when draining into IVC.

The Anatomical knowledge of multiple renal areteries is essential before performing any transplanatation surgeries, where microvascular techniques are employed to reconstruct the renal arteries [16]. The embryological basis of these variations has been presented and discussed by Keibel F and Mall FP [17]. In a 18mm fetus, the developing mesonephros, metanephros, suprarenal glands and gonads are supplied by nine pair of lateral mesonephric arteries arising from dorsal aorta. Felix [17] divided these arteries into three groups as follows: the 1st and 2nd arteries as the cranial group, the 3rd and 4th arteries as the middle group and 6th and 9th arteries as caudal group. The middle group gives rise to renal arteries. Persistence of more than one renal arteries of the middle group results as multiple renal arteries. So duplicated renal arteries are due to persisting lateral mesonephric arteries from the middle group. Further Sharmista Biswas et al [18] reported a case of variation of renal and testicular veins in their routine dissection, on the right side there was an additional renal vein that drained directly into IVC. Ugur Ozkan et al [19] studied abdominal angiography of 855 patients, there was single renal artery in 76% of the patients. Multiple renal arteries were found in 202[24 %] cases, more than one renal artery on right side in 135 cases [16%] and left side in 113 cases [13%].

Madhur Gupta et al [20] reported a horseshoe kidney, right side kidney was drained by three veins directly into IVC. Timothy K et al [21] operated on a 55 year old female who was referred for gross hematuria and planned for laparoscopic left radical nephrectomy. Upon hilar dissection, the IVC was

encountered without visualization of aorta. In additional 3 renal veins were encountered. The surgery was uneventful and kidney was removed successfully.

Nayak B. S et al [22] found a case where right kidney showed three arteries, superior renal artery was divivided into three branches and middle and inferior renal arteries were divided in to 2 branches each. The right kidney also showed 2 renal veins of equal size. According to Testut and Latarjet [23] and Bergmann et al [24] the renal veins shows less variation than to renal arteries and studies done by Pick and Anson [25] found supernumerary arteries are seen in 32.25% of kidneys and supernumerary veins are seen in 14.4% so that supernumerarary arteries seem to be atleast twice as common as as supernumerary arteies. In the present study also double renal arteries was seen in 14.28% of cases and double renal veins was seen in 3.57% of cases [Table No. 1 and 2], so this study results are reporting that multiple arteries incidence are thrice more than the multiple veins and thus also supports the sentence that supernumerary arteries are common than supernumerary veins, as told by earlier authors.

Renal Pelvis

Renal pelvis is the upper expanded part of ureter. Malformations of urinary system are relatively common compromising about 3% of live births [1]. The reported incidence of ureteral duplication varies widely among different series depending on the clinical data, survey or autopsy. Duplication of pelvis and the ureter results from early splitting of ureteric bud [23]. Splitting may be partial or complete , ureteric may divide before penetrarting the metanephric tissues, thus giving rise to a bifid ureter having a single opening into the bladder. In case of very early division of ureteric bud, there is incorporation of ureteric division into posterior aspect of urogenital sinus which results in duplication of ureter with separate orifices for each. Bifid ureter unless symptomatic might be detected during investigations or incidential findings at autopsy. Sometimes there are features of reflux and as a result urinary calculi [26], pyelonephritis and ureterohydronephrosis develop [27].

In 1926, Archangelski [28] in his series of studies of ureter by radiological method [619 cases] and autopsy method [3 cases] found that unilateral duplication of ureter was 502 cases [80%] and bilateral duplication in117 cases[20%]. Out of 4215 autopsies done by Lowsly et al [29], there was 18 cases of incomplete duplication among them 2 were bilaterally incomplete , 7 were unilaterally incomplete and 9 were unilaterally complete duplicate. Ochoa Urdangarian et al [30] reported a complete triple ureter and a 27 year old female patient consulted for episodes of right renal colic, several studies including intravenous urography and CT scans were performed revealing a right renal lithiasis and double ureteral pyelocaliceal system on the right side, the left kidney showed 3 pyelocalyceal system with 3 ureters each of them draining separatelty into the bladder. Gawlik Jkubczak T et al [31] evaluating a case of hypertension by ultrasound which revealed a giant hydronephrosis with double pelvis and ureter on left side. Nation [5] observed 109 cases of duplication of ureter in 16000 autopsies with an incidence of 0.68% where as Campbell [32]in his personal series of 51,880 autopsies observed 342 ureteric duplication with rate of 0.66%. Combining Nation [5] and Campbell [32] series the projected incidence of duplication is 1 in 125 or 0.8%, unilateral duplication is more common than the bilateral duplication. In our present study [Table No. 3] also, out of 84 kidneys only one kidney showed duplication of pelvis and ureter which accounts to be 1.19% which is close to the studies done by Nation [5] and Campbell [32] series of autopsies.

Conclusion

By this study it can be reported that supernumerary arteries are more common than supernumerary veins and duplication of pelvis though the incidence is less in this study, the urologist and radiologist should keep in mind of such duplications and supernumerary vessels. This present study is an attempt to add an interest in multiple renal vessels and duplex pelvis and to add to the knowledge of surgeons and radiologist for a betterment of their diagnosis and treatment of patients.

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Original Article

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Variation of Venous System in Popliteal Fossa

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Abstract

Objective: The popliteal vein is the main vein of lower limb, generally accompanied by the popliteal artery in the popliteal fossa. It is of great importance to have the knowledge of the veins of the lower limb and their anomalies, so as to avoid any vascular injury during the surgery on lower limb and for improved assessment and treatment of deep vein thrombosis. Hence, retrospectively to review and evaluate the types of variations and their frequencies seen within the popliteal fossa, we carried out a cadaveric study in the Department of Anatomy of Dr P.D.M.M.C. Amravati. *Materials and Methods:* In the dissection hall, during routine dissection of formalin fixed cadavers of the adult donors a retrospective study of 20 bilateral (40 unilateral) lower limbs was performed. *Results:* We found one variation in lower limb vein of a 64 year male cadaver. In this case, the popliteal vein instead of continuing as femoral vein bifurcated into two veins one of which separately opened into the femoral vein in the femoral triangle. *Conclusion:* Variations in popliteal fossa venous anatomy have many important clinical implications in deep venous thrombosis as well as in lower limb surgery .

Keywords: Adductor Magnus; Popliteal Vein; Femoral Vein; Profunda Femoris Vein.

Introduction

The knowledge of popliteal vein and femoral vein variations is important for planning of some interventional procedures. The variations in the anatomy of lower extremity venous system have been studied with the use of cadavers, venography and ultrasonography .These studies have shown different results depending on the study population and the different modalities used [1]. The venous drainage of lower extremity is of great importance as the veins are prone to thrombus due to long term immobilisation or accidents. Let us consider a brief review of the veins of the lower limb.

In lower limbs, the most commonly present two venous systems of blood collection are the deep and superficial according to the two compartments .The third system of perforating veins connect the deep with the superficial veins. Upto the knee joint the veins are generally paired and above the knee the main trunks ie popliteal,femoral and the profunda femoris are without duplication [2] . Only 17% will have this 'normal' venous anatomy. About more than 45% have duplicated multiple vessels and the popliteal vein is the common vein found with variation next to the femoral vein [2]. In very rare conditions, the popliteal vein establishes connection with the profunda femoris vein.

The deep veins of the foot and leg drain into popliteal vein which ascends to form the femoral vein. The femoral vein receives the profunda femoris vein as a tributary from deep part of the front of the thigh 8 to 9cm away from inguinal ligament [3].

The popliteal vein begins at the lower border of the popliteus muscle by joining of anterior and posterior tibial veins. Throughout its course the popliteal artery is lying deep to the popliteal vein in the same fibrous sheath.

The vein is initially posteromedial to the popliteal artery, lateral to the tibial nerve. More superiorly it is posterior to the artery and anterior to the tibial nerve. Little above, it lies lateral to the artery at the upper

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border of popliteal fossa. Superiorly the popliteal vein becomes femoral vein as it traverses the adductor hiatus. The small saphenous vein passes from posterior aspect of lateral malleolus to the popliteal fossa and it pierces the deep popliteal fascia and enters the popliteal vein.

Materials and Methods

In the dissection hall, during routine dissection of formalin fixed cadavers of the adult donors a retrospective study of 20 bilateral (40 unilateral) lower limbs was performed . Deep veins present in popliteal fossa were evaluated for the presence of any duplication and also interindividual variations in the venous anatomy.

Results

We found one variation in lower limb vein of a 64 year male cadaver. In this case, the popliteal vein instead of continuing as femoral vein bifurcated into two veins one of which separately opened into the femoral vein in the femoral triangle. In all the rest of 39 lower limbs , the popliteal vein continued till the upper end of popliteal fossa and then above as the femoral vein.

We describe a rare variation of popliteal vein which terminated into two different veins.

Case Report

The present case was observed during routine dissection of a male cadaver aged 64 years. In this case, the popliteal vein of left limb, was present at the superior angle of popliteal fossa terminated into two veins. One as the femoral vein which continued upwards and pierced the adductor magnus and other was the tributary which went vertically upwards separately and opened into the femoral vein called profunda femoris vein.

This other (profunda femoris) vein was as long as 19 cms. and was opening into the femoral vein near its upper end. These three were covered by hamstring muscles . The femoral vein was normal in thickness, about 20 cms in length and was accompanied by femoral artery as it ascended through the adductor magnus to the femoral triangle. So, the popliteal vein instead of directly continuing as femoral vein, terminated into two veins namely the femoral vein and the profunda femoris vein.

When traced proximally there were two tributaries of the popliteal vein draining from the lateral border of the leg 1) The short saphenous vein and 2) Superficial Vein of the leg.

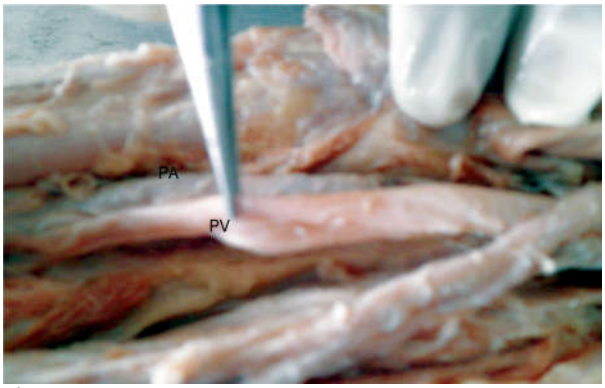

Fig. 1:

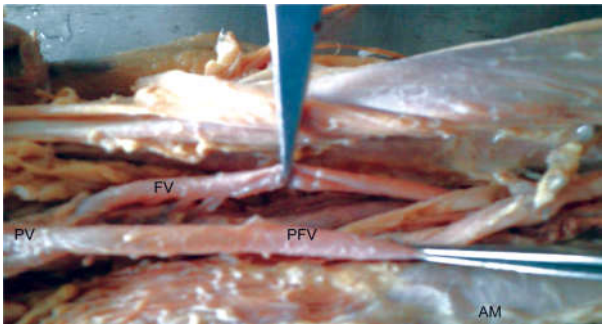

Fig. 2:

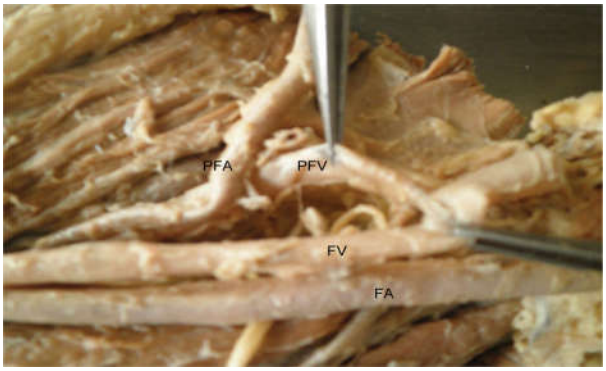

Fig. 3:

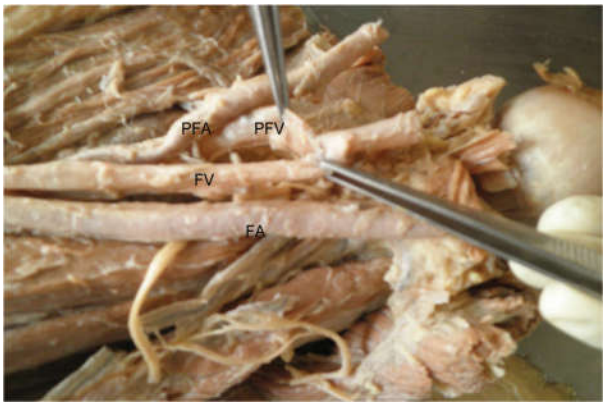

Fig. 4:

These were draining into the popliteal vein in the popliteal fossa where the posterior tibial vein joined the anterior tibial vein. In the right lower limb , the arrangement of veins was normal .

We observed 1. In photo1, the popliteal fossa showing popliteal artery and popliteal vein. 2. In photo 2, the popliteal vein dividing into 2 veins , the femoral and the profunda femoris vein. Femoral vein entered the adductor magnus muscle 3. In photo 3 and photo 4, the femoral vein and the profunda femoris vein in femoral triangle. The profunda femoris artery was cut for better visualization. [PA, PV -popliteal artery, vein. FA, FV- Femoral artery, vein. PFA, PFV- Profunda femoris artery and vein]

Discussion

The complex embryological development of vascular system often results in various anomalies. It is stated that the classic anatomical venous return pattern in lower extremity is found only in 16% of the patients [4]. Even though we could not provide embryological background of all the observed variations, we believe that comprehensive list of all 3D variations of femoropopliteal vein can provide an insight to formulate a hypothetical model for the development of venous system of lower extremity [1]. The duplication in popliteal vein may result in false negative deep vein thrombosis study, and consequently failure in the diagnosis of thrombotic disease and ultimately pulmonary embolism.

Variations of venous anatomy in the popliteal fossa are common and have important implications in diagnosis of deep venous thrombosis [2]. Caution should be exercised when a popliteal vein is duplicated because of high confluence of posterior tibial vein as duplication [5]. Thromboembolic disease is a process of deep vein thrombosis alongwith pulmonary embolism. Most of the pulmonary embolisms are thought to originate in the deep veins of the lower extremity [4]. Kambal et al studied variations and the role of ablation in the management of symptoms and skin changes [6].

Much of the literature on lower extremity venous duplication is based on venography studies. The prevalence in these studies varies widely from 4-5% for popliteal vein and upto 46% in femoral vein [5,6,7]. It is of great importance during the surgery on lower limb, to avoid any vascular injury and related complications intraoperatively as well as postoperatively.

The duplication of lower extremity venous system is the anatomical variation which is the most common reason for a false negative deep vein thrombosis study that consequently results in failure to diagnose venous thrombotic disease and ultimately the pulmonary embolism [5].

Hence, the knowledge of the veins of the lower limb and the knowledge concerning the incidence and distribution of venous anomalies is utmost required for detecting the underlying anatomical variation for improved assessment and treatment of venous disease [4].

In the obstruction or thrombosis of profunda femoris vein, phlebology gives a great deal of information about collateral blood flow [9].

The variations in the anatomy of lower extremity venous system have been studied with the use of cadavers, venography and ultrasonography .However venography has not been considered as an appropriate procedures it needs that all the vessels to be filled by the contrast which is often not possible .Nowadays, multidetector CT is a upcoming recent technique for the presence of any variant vein or accompanying small artery [8,10,11,12].

A substantial number of studies had been published when follow up of patients with the negative above-knee ultrasound results [13,14,15,16,17] or negative single full-leg ultrasound results were done [18,19,20,21]. These studies reported that there was low rate of thromboembolic event over the subsequent 3 months. The analysis also suggested that the follow ups were cost- effective.

However, the concerns about costs, complications, contraindications and radiation dose have led a decrease in the use of venography, such that it is limited to only a selected group of patients [22].

Further anatomical and functional studies using new imaging modalities available should target the areas within 5 cm of the inguinal ligament, within 3 cm of the profunda femoris vein and in the popliteal vein near the adductor hiatus to identify whether certain valves play a more important role in venous disease. This may guide us in the development of new treatment options for patients with deep venous disease[23].

Conclusion

In our study, the variation in popliteal vein of the left lower limb was found . The duplication of lower extremity venous system is the anatomical variation which is the most common reason for a false negative

result. In deep vein thrombosis study consequently there are chances of failure to diagnose venous thrombotic disease and ultimately the pulmonary embolism. The use of venography, now a days is limited as new imaging modalities like 3D sonography and Doppler sonography, multi detector CT scan, magnetic resonance imaging etc. are available.

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Original Article

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Study of Gender Differences in Palmar Dermatoglyphics among Healthy Adults

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Abstract

Background & Objectives: Fingerprint (dermatoglyphic) evidence is undoubtedly the most reliable and acceptable evidence till date in the court of law. Due to the immense potential of fingerprint as an effective method of identification an attempt has been made in the present work to analyse their correlation with gender of an individual. This study was done to determine significant differences in palmar dermatoglyphic parameters between males and females. *Methods:* Residents of Nijalingappa colony of Raichur in Karnataka were the source of this study. 50 adult healthy males in the age group of 20 to 40 years and 50 adult healthy females of same age group were the subjects for this study. Sample collection was done by doing home visits and collecting palmar impression. Fingerprint pattern of all of them was recorded using duplicating ink. The prints were then subjected to dermatoglyphic analysis. *Results:* The Total Finger Ridge Count (TFRC) was significantly more in males compared to females. Females had significantly higher a-b ridge counts than males. There were no significant differences in the other parameters between males and females. *Interpretation & Conclusion:* The gender differences in the dermatoglyphic patterns of palms are established by this study. This information is useful in forensic studies in identifying gender of a person.

Keywords: Dermatoglyphics; Hand; Fingers; Male; Female; Forensic Medicine.

Introduction

Gender and Age information is important to provide investigative leads for finding unknown persons. Existing methods for gender classification have limited use for crime scene investigation because they depend on the availability of teeth, bones, or other identifiable body parts having physical features that allow gender and age estimation by conventional methods. Various methodologies has been used to identify the gender using different biometrics traits such as face, gait, iris, hand shape, speech and fingerprint. The science of fingerprint has been used generally for the identification or verification of person and for official documentation. Two persons having identical fingerprint is about one in 64 thousand millions. A reliable personal identification is critical in the subject of forensic medicine as is faced with many situations like civil, criminal, commercial and latest in financial transaction frauds, where the question of identification becomes a matter of paramount importance [1].

Dermatoglyphics are also used in the branch of forensic medicine for individual identification. It is a valuable research tool in the field of physical anthropology, human genetics and medicine. Recently, a few researches have been carried out on this aspect of fingerprint [2-6]. All of these papers have reported higher epidermal ridge density in females as compared to males. The present study has been carried out to study such correlation between gender and dermatoglyphics.

Objective

This study was done to determine significant differences in palmar dermatoglyphic parameters between males and females.

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Materials and Methods

Source of Data

Residents of Nijalingappa colony of Raichur in Karnataka were the source of this study. 50 adult healthy males in the age group of 20 to 40 years and 50 adult healthy females of same age group were the subjects for this study. Sample collection was done by doing home visits and collecting palmar impression.

Sample Size

For the present study 100 subjects (50 males and 50 females) were taken.

Inclusion Criteria

1. Adults in the age group of 20 to 40 years.
2. No past history of any chronic illnesses like Diabetes Mellitus, Hypertension etc.

Exclusion Criteria

1. History of any chronic illness.
2. Deformity or injury to the hand.
3. Those having worn finger-prints, extra, webbed or bandaged fingers.
4. Chromosomal abnormalities like Klinefelter's syndrome, Turner's syndrome etc.

Sampling Procedure

Patients were asked to wash both their hands with soap and water, so as to remove any oil or dirt. The duplicating ink is smeared on both hands uniformly over the palm and digits by the roller taking care that hollow of the palm and the flexor creases of the wrist were uniformly inked. The hand of the patient was then placed on the bond paper from proximal to distal end. The palm was gently pressed between inter-metacarpal grooves at the root of fingers and on the dorsal side corresponding to thenar and hypothenar regions. The procedure was repeated with the other hand on a separate paper (Figures 1 to 3).

The prints were then subjected to dermatoglyphic analysis with the help of magnifying hand lens and protractor and ridge counting was done with the help of a sharp needle. The details were noted.

The quantitative analysis was done with parameters that included Total Finger Ridge Count (TFRC), Absolute Finger Ridge Count (AFRC), ridge count of individual fingers, a-b ridge count, angles atd, dat, adt and main line index. The qualitative tests included finger print patterns, palmar patterns, C-main line type, main line terminations and palmar flexion creases. The master chart thus prepared was subjected to statistical analysis.

Data was expressed in mean (SD). Descriptive statistics was used such as mean, SD etc. Comparison between groups, hands and gender was done using z-test for large sample for continuous variable and for categorical variable, contingency coefficient was used. A p-value less than 0.05 considered as significant and 0.01 as highly significant. All the statistical calculations were done by SPSS v16.0. P value is the probability rate at 0.05 level of significance for the corresponding degree of freedom. $P < 0.05$ is significant. $P > 0.05$ is non-significant.

Results

The Total Finger Ridge Count (TFRC) was significantly more in males compared to females, while there was no significant differences in Absolute Ridge Count (AFRC) between males and females (Table 1). When analysis was done among the male subjects only, no significant difference was observed between left and right hand TFRC and AFRC of male subjects (Table 2). When analysis was done among the female subjects only, no significant difference was observed between left and right hand TFRC and AFRC of female subjects (Table 3). In our study, females had significantly higher a-b ridge counts than males while no significance difference was observed between left and right hand a-b ridge counts in both sexes (Table 4). There was also no significant differences in the a-b ridge count and Main Line Index (MLI) between males and females in our study (Table 5). No significant difference was observed in the atd, dat and adt angles of right and left hands of the male group (Table 6). In a similar way, no significant difference was observed in the atd, dat and adt angles of right and left hands of the female group (Table 7). Also, no significant difference was observed in the atd, dat and adt angles when compared between males and females (Table 8). There was no significant difference between left and right hands in all D1, D2, D3, D4 and D5 finger tip ridge count in male subjects (Table 9). Similarly, in females too, there was no significant difference between left and right hands in all D1, D2, D3, D4 and D5 finger tip ridge count (Table 10). Also, in all D1, D2, D3, D4 and D5 finger tip ridge patterns, non-significant associations were observed between male and female groups as all the

obtained contingency coefficient values were found to be non-significant (Table 11). When the C-Main Line Termination type frequency was studied, for both left and right hands, in both male and female group, significant association was not observed (Table 12). When the Main Line Formula type frequency was studied, for both left and right hands, in both male and female group, significant association was not observed (Table 13). When the t-axial triradii position frequency was studied, for both left and right hands, in both male and female group, significant association was not observed (Table 14).

Thus, in our study, the Total Finger Ridge Count (TFRC) was significantly more in males compared to females. Females had significantly higher a-b ridge counts than males. There were no significant differences in the other parameters between males and females.

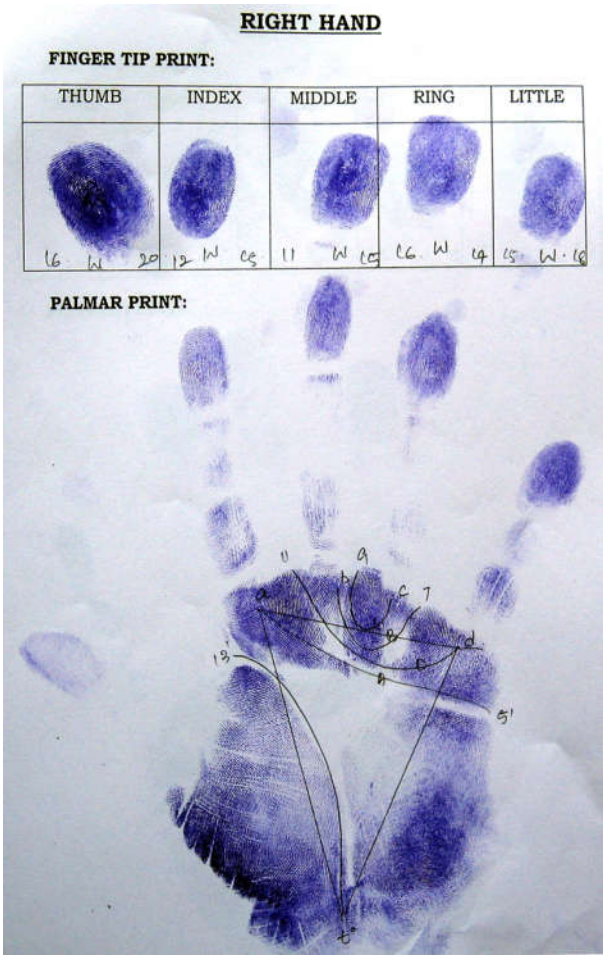

Fig. 1: Palmar print of right hand in an adult male

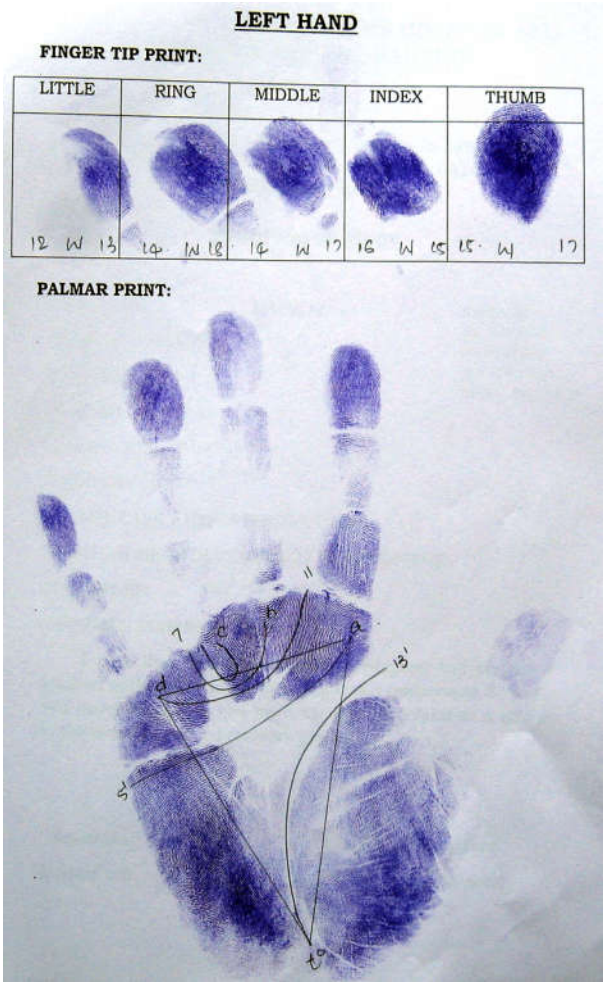

Fig. 2: Palmar print of left hand in an adult female

Table 1: Total and absolute finger ridge counts in 100 subjects (50m, 50f) (hands combined)

Variables	Subjects			Z-value	Significance
	Male Mean (SD)	Female Mean (SD)	Total Mean (SD)		
TFRC	56.26 (18.7)	48.83 (15.5)	52.5 (17.1)	2.16	Significant
AFRC	78.09 (35.7)	69.41 (30.0)	73.8 (32.9)	1.32	Not significant

Table 2: Total and absolute finger ridge counts in 50 male subjects (hands separate)

Variables	Subjects			Z-value	Significance
	Left Mean (SD)	Right Mean (SD)	Total Mean (SD)		
TFRC	56.8 (18.9)	55.7 (18.6)	56.3 (18.8)	0.29	Not Significant
AFRC	77.3 (36.3)	78.9 (35.4)	78.1 (35.9)	0.22	Not Significant

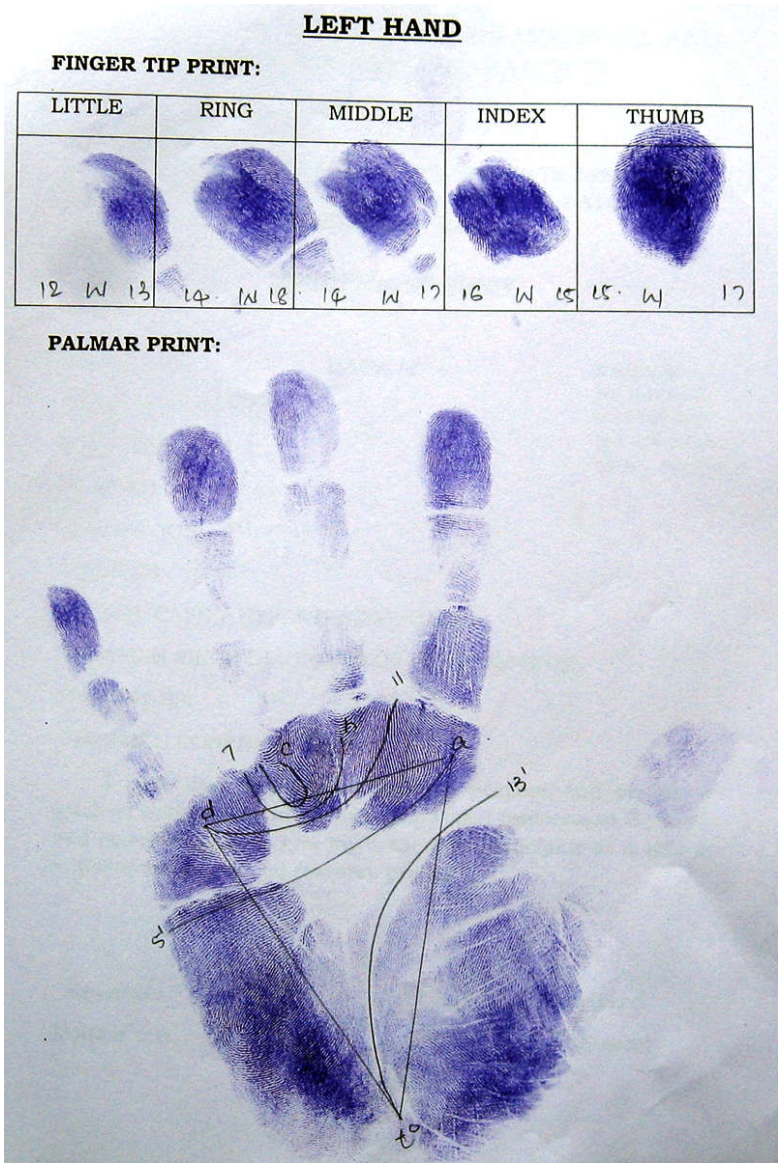

Fig. 3: Proforma for recording the dermatoglyphic parameters

Table 3: Total and absolute finger ridge counts in 50 female subjects (hands separate)

Variables	SUBJECTS			Z-value	Significance
	Left Hand Mean (SD)	Right Hand Mean (SD)	Total Mean (SD)		
TFRC	48.9 (15.7)	48.8 (15.3)	48.9 (15.5)	0.03	Not Significant
AFRC	70.9 (30.6)	67.9 (29.6)	69.4 (30.1)	0.49	Not Significant

Table 4 : A-B ridge counts in 100 subjects (50m, 50f) (hands separate)

Hand	Sex	Mean	SD	Z-value	Significance
Left	Male	28.76	7.0	1.46	Not Significant
	Female	30.42	3.9		
	Total	29.59	5.5		
Right	Male	27.38	6.4	1.47	Not Significant
	Female	28.90	3.5		
	Total	28.14	4.9		
Total	Male	28.07	6.67	2.07	Significant
	Female	29.66	3.77		
	Total	28.87	5.22		

Table 5: A-B ridge count and main line index in 100 subjects (50m, 50f) (hands combined)

Variables	Male Subjects Mean (SD)	Female Subjects Mean (SD)	Total Subjects Mean (SD)	Z-value	Significance
MLI	10 (1.8)	9.4 (1.8)	9.7 (1.8)	1.66	Not Significant
a-b	28.1 (6.7)	29.7 (3.8)	28.9 (5.5)	1.46	Not Significant

Table 6: Angles atd, dat, adt in 50 male subjects (hands separate)

Variables	Left Hand Mean (SD)	Right Hand Mean (SD)	Total Mean (SD)	Z-value	Significance
Atd	40.3 (8.9)	41.2 (6.9)	40.7 (8.0)	0.56	Not Significant
Dat	58.7 (9.4)	58.5 (5.3)	58.6 (7.6)	0.13	Not Significant
Adt	78.7 (12.7)	81.6 (4.2)	80.2 (9.5)	1.53	Not Significant

Table 7: Angles, atd, dat, adt in 50 female subjects (hands separate)

Variables	Left Hand Mean (SD)	Right Hand Mean (SD)	Total Mean (SD)	Z-value	Significance
ATD	40.4 (4.7)	40.2 (4.1)	40.3 (4.4)	0.22	Not Significant
dat	59.4 (5.2)	58.9 (9.9)	59.1 (7.9)	0.31	Not Significant
ADT	80.5 (3.5)	80.1 (7.3)	80.3 (5.7)	0.34	Not Significant

Table 8: angles, atd, dat, adt in 100 subjects (50m, 50f) (hands combined)

Variables	Male Subjects Mean (SD)	Female Subjects Mean (SD)	Total Mean (SD)	Z-Value	Significance
ATD	41.1 (6.9)	40.3 (4.4)	40.7 (5.8)	0.69	Not Significant
DAT	59.2 (4.8)	59.1 (7.9)	59.1 (6.5)	0.07	Not Significant
ADT	81.0 (5.0)	80.3 (5.7)	80.6 (5.4)	0.65	Not Significant

Table 9: Finger tip ridge count in 50 male subjects (hands separate)

Variable	Left Hand Mean (SD)	Right Hand Mean (SD)	Total Mean (SD)	Z-value	Significance
D1	14.9 (8.0)	17.1 (7.8)	16 (7.9)	1.39	Not Significant
D2	14.1 (8.4)	13.1 (7.6)	13.6 (8)	0.62	Not Significant
D3	14.8 (7.5)	13.5 (8.4)	14.2 (7.9)	0.81	Not Significant
D4	17.4 (6.3)	17.3 (7.9)	17.4 (7.1)	0.07	Not Significant
D5	12.3 (5.1)	12.1 (6.0)	12.2 (5.6)	0.18	Not Significant

Table 10: Fingertip ridge counts in 50 female subjects (hands separate)

Variables	Left Hand Mean (SD)	Right Hand Mean (SD)	Total Mean (SD)	Z-value	Significance
D1	15.8 (8.7)	15.3 (8.8)	15.5 (8.7)	0.28	Not Significant
D2	13.1 (8.5)	13.9 (7.8)	13.5 (8.1)	0.49	Not Significant
D3	13.6 (8.1)	12.5 (6.7)	13.0 (7.4)	0.74	Not Significant
D4	16.7 (7.3)	16.6 (7.7)	16.7 (7.5)	0.06	Not Significant
D5	11.3 (6.3)	10.8 (5.9)	11.1 (6.1)	0.41	Not Significant

Table 11: Finger tip pattern frequency in 100 subjects (50m, 50f) (hands separate)

Variables		LEFT		RIGHT	
		Male Subjects	Female subjects	Male subjects	Female subjects
D1	Whorl	19	27	28	21
	Arch	3	4	0	4
	Loop	28	19	22	25
	Contingency coefficient	0.177	P= 0.196		0.22 P=0.07
D2	Whorl	21	25	22	27
	Arch	3	8	4	5
	Loop	26	17	24	18
	Contingency coefficient	0.21	P=0.105	0.12	P=0.47
	Whorl	21	21	19	15

	Arch	2		4	2	2
	Loop	27		25	29	33
	Contingency coefficient	0.08	P=0.69		0.08	P=0.69
D4	Whorl	31		32	30	29
	Arch	0		0	0	1
	Loop	19		18	20	20
	Contingency coefficient	0.02	P=0.84		0.10	P=0.6
		(Calculated only for two rows as 'arch' was nil in both the group)				
D5	Whorl	17		14	18	13
	Arch	0		3	0	1
	Loop	33		33	32	36
	Contingency coefficient	0.17	P=0.19		0.14	P=0.36

Table 12: C-main line termination type frequency in 100 subjects (50m, 50f) (hands separate)

Variables		Male subjects	Female subjects
Left	C-Absent	2	1
	C-Ulnar	19	24
	C-Radial	29	25
	Contingency coefficient	0.10	P=0.55
Right	C-Absent	1	0
	C-Ulnar	17	26
	C-Radial	32	24
	Contingency coefficient	0.20	P=0.13

Table 13: Main line formula type frequency in 100 subjects (50m, 50f) (hands separate)

Variables			Male subjects	Female subjects	
LEFT	11 9 7 5′ 13′		16	15	
	9 7 5′ 4 13′		2	2	
	7 5′′ 5′ 4 13′		1	1	
	Others		31	32	
	Contingency coefficient	0.02			P=0.99
RIGHT	11 9 7 5′ 13′		16	14	
	9 7 5′ 4 13′		0	4	
	7 5′′ 5′ 4 13′		1	1	
	Others		33	31	
	Contingency coefficient	0.20			P=0.24

Table 14: T-axial triradii position frequency in 100 subjects (50m, 50f) (hands separate)

Variables			Male subjects	Female subjects	
LEFT	T		45	44	
	t^1		5	6	
	$t + t^1$		0	0	
	Contingency coefficient	0.03			P=0.74
			(Calculated only for two rows as 't + t¹' was nil in both the group)		
RIGHT	T		43	48	
	t^1		6	2	
	$t + t^1$		1	0	
	Contingency coefficient	0.18			P=0.19

Discussion

Dermatoglyphics is the scientific study of epidermal ridges and their configurations on palmar region of hand and fingers and plantar region of foot and toes. It is also known as 'Epidermal ridge configurations'[7]. The term dermatoglyphics was coined by Cummins and Midlo in 1926. It was derived from the Greek words-derma (skin) and glyphics (curve). The scientific study of papillary ridges of hands and feet was first begun in 1823 by Evangelista Purkinje –a Czech physiologist and biologist. He was the first who systematically categorized finger print pattern [8].

Development of epidermal ridges is first seen in the form of localized cell proliferation in the basal layer of epidermis around 10^{th} to 11^{th} week of human prenatal development. These cells proliferations form epidermal ridges that project into dermis. The number of primary ridges, as they are termed continues to

increase by the formation of new ridges between existing ridges or from existing ridges on the periphery of the pattern [9]. The epidermal ridges are differentiated in their definitive form during 3rd and 4th month of fetal life, hence they are the significant indicators of conditions existing several months prior to birth of individual. The original ridge characteristics are not disturbed unless the skin is not damaged up to a depth of about one millimeter [7]. According to Penrose , seven genes are thought to be involved in the fingerprint formation. In polygenic inheritance, the genes that confer this follow Mendel's laws, but, together, they do not produce a single-gene phenotypic ratio. Instead, they all contribute to the phenotype without being dominant or recessive to each other.The epidermal ridge configuration and their component ridges enlarge with growth, but their essential characteristics remain the same throughout life [10].

In 1892 Sir Francis Galton demonstrated that epidermal ridge configuration did not change throughout postnatal life. The fact that ridge configurations are not affected by environment or by age, has been an important framework in genetic studies. While the genetic basis of dermatoglyphic traits has been well established, current research suggests that the genetic component of dermatoglyphic traits operates indirectly on ridge configuration through ontogenetic factors, pad topography, growth rates and stress on epidermis, that influence ridge alignment [11]. Abnormal dermatoglyphic pattern have been observed in several non-chromosomal genetic disorders or other diseases whose etiology may be influenced directly or indirectly by genetic inheritance [12]. There are thousands of diseases known to be caused by abnormal genes. If there is any abnormality in the genetic makeup of parents, it is inherited to the children and is reflected in dermatoglyphic patterns. It has been observed that dermatoglyphic shows definite diagnostic changes in those disorders which show genetic basis[7].

The dermatoglyphic ridges are differentiated in their definitive forms during third and fourth month of foetal life and once formed remain permanent and never change throughout the life except in the dimension in proportion to the growth of an individual. The original ridge characteristics are not disturbed unless the skin is damaged to a depth of about one millimeter [7]. Development of dermatoglyphic pattern is under genetic control. This is evident from the clear resemblance of dermatoglyphics among related person[13]. Dermatoglyphics as a diagnostic aid is now well established in a number of diseases, which have a strong hereditary basis, and is employed as a method of screening abnormal anomalies [14].The research findings put forth by some scientists suggest that muzzle prints of animals similar to fingerprints in human being could be used as permanent method of identification of such animal to check fraud particularly in insurance matter [15].

Medical interest in dermatoglyphics developed only in the last few decades and knowledge of the type of deviations associated with various medical disorders can add appreciably to the diagnostic armamentarium of the clinician. Diabetes, Congenital heart disease, Mongolism, Down's Syndrome, Schizophrenia, Leukemia, Thalassemia, are a few conditions to mention which utilized dermatoglyphics for its easy applicability, reproducibility, reliability, for early detection and management of high risk population. In this study, we found out some significant differences in dermatoglyphic parameters between males and females. This knowledge can be extrapolated in concluding that certain disorders are more common in particular sex.

Total Finger Ridge Counts (TFRC)

TFRC is the summation of the ridge counts from the fingers of both hands. In our study, the Total Finger Ridge Count (TFRC) was significantly more in males compared to females. Earlier work on gender classification based on the ridge density shows that the ridge density is greater for female than male [2,16,17,18] and G. G. Reddy analysed fingerprints of bagathas a tribal population of Andhra Pradesh (India) and showed the evident that the males showing higher mean ridge counts than females [19]. In a similar study in Philippines, Sally et al. found out that males have higher TFRCs than females [20].

A-B Ridge Counts

A ridge count is the number of ridges intervening between the triradius and the core or centre which cuts or touches a straight line joining these two points in a finger [21]. In our study, females had significantly higher a-b ridge counts than males. In a study by Hossein Rezaei Nezhad and Nasser Mahdavi Shah, there was no significant difference among the mean of a-b ridge between males and females [22].

In our study, there were no significant differences in the other parameters between males and females. Bhat GM et al conclude in their study that, in general, females have narrow ridges, more arches and fewer whorls. Females also have large frequency of hypothenar IV interdigital patterns [23]. Cummins et

al. established that males have coarser epidermal ridges than females [24]. Ohler and Cummins reported that males have a ridge breadth of 0.48 mm, whereas females have 0.43 mm, but none of them have included the furrow breadth [25]. This was taken into consideration by Moore who reported a higher value of ridge to ridge distance in males and thus a lesser ridge density as compared to females [26].

Based on the obtained results in our study, we can conclude that there are differences in dermatoglyphic parameters between women and men, and they can be used to determine the gender of the donor. This study can be used as a sorting parameter in cases where there are a large number of fingers prints available in case work analysis. The results from the study are quite encouraging and this ultimately would be helpful as a useful tool for the fingerprint experts either in the field of Forensic Science or law enforcement field [27].

Conclusion

From the present study, it appears that there do exists a variation in the dermatoglyphic patterns between male and female population. The method of identifying these variations is simple and inexpensive. Moreover the materials required for the dermatoglyphic procedure are easily available and portable. Identification by finger prints is infallible and now with the help with this study it will be further helpful to the fingerprint expert to direct their search to a particular gender and eventually the investigating officers would save time in nabbing suspects in a criminal case.

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Original Article

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Determination of Sex and Age from Human Clavicles and its Radiographic Images

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Abstract

Introduction: The determination of sex and age of an individual is primary criteria of identification, but this is very difficult problem and becomes even more challenging when only a single bone like clavicle is available. The traditional methods of sexing bone are subjective and not of much help in medico legal cases where near 100% accuracy is needed. *Aims:* 1. Determination of sex and age of clavicle with the help of morphometric analysis. 2. Determination of age of clavicle with the help of digital X-rays. *Methodology:* This study was performed using 130 dry human clavicles with institutional ethical committee approval. Morphometric analysis of adult clavicles (108) was carried out using weighing machine, vernier calipers, scale, etc. Roentgenographic observations including adult (108) and young aged clavicles (22) were noted to estimate age with the help of visual seriation. *Results & Conclusion:* There was a significant difference in parameters like length, mid shaft circumference; weight and incidence of rhomboid fossa were observed between male and female clavicles. The present study emphasizes in the possibility of age estimation with the external appearance of medial end and X- ray observations of clavicle.

Keywords: Clavicle; Age Determination; Sex Determination; Medial End of Clavicle; Rhomboid Fossa; X-Rays.

Introduction

Clavicle is the only long bone which is placed horizontally and it possesses many gender and age specific metric and non-metric traits [1]. Estimation of age and sex of deceased is easy when a complete skeleton is available for examination. But, the determination of sex and age of an individual becomes challenging when a single bone like clavicle is available [2]. It presents a task of considerable importance from the view-point of the administration of justice [3].

Dimensions of clavicle like length, mid shaft circumference, weight were lesser in female than male, an amalgamation of these dimensions capitulate better results in identifying the sex of the individual [4].

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Estimation of age with the stage of ossification of the medial epiphysis among subjects below adolescent age is less complicated but the task becomes more crucial to assess age of an adult individual with a single clavicle bone. Radiography of clavicle is considered as one of the indices like teeth eruption, X- ray of left hand, orthopantomogram to estimate age of the subject [5].

The purpose of the present study is to determine the sex with morphometric analysis of dry human clavicles and to estimate the age with external appearance of medial end and visual seriation of radiographic pictures of clavicle.

Material and Methods

One hundred and thirty clavicles with predetermined sex were included in the study, all the bones were obtained from cadavers, being dissected in Department of Anatomy, Vinayaka Missions Kirupananda Variyaar Medical College, Salem. Tamil Nadu. The Institutional Ethical clearance was obtained to conduct the study. Out of which 108 adult clavicles (69 right and 61 left) and rest of them were

22 young aged clavicles (<23 years). Only adult clavicle were included in the study pertained to sex of the clavicle. Out of 108 adult clavicles 53 are male clavicles (29 right and 22 left), 55 are female clavicles (23 right and 32 left) and all 130 clavicles were included in determining age. Clavicles showing any pathology e.g. a healed fracture or mal-union, were excluded. Before analysis bones which were included in the study were boiled cleaned and dried.

Morphometric analysis of clavicle (A manual of biological anthropology) [6] – The maximum length of the clavicle (in mm) was measured with the help of digital vernier caliper was taken. Weight (in gm) was weighed with the help of digital weighing machine. Mid shaft circumference (MSC) was measured (in mm) while measuring the length of clavicle, a mark was done at the middle between two ends and circumference was measured with the help of thread and marked. The marked ends were measured with digital vernier caliper. The bones were visually examined for occurrence of rhomboid fossa and length and breadth were measured with digital vernier caliper and nature of rhomboid fossa noted whether it is flat, elevated or depressed [7] (Fig 1).

Formulas used to derive the Robustness Index (RI) and Index of Rhomboid Fossa (IRF) are

RI = MSC/Maximum length of clavicle ×100

IRF = Breadth of RF/ Length of RF×100

The methods reported here for age determination are from visual appearance of medial end of clavicle and from the radiographs.

Age Determination By the External Appearance of Medial Articular Surface

Based on McKern and Stewart's system [8] clavicles were classified into 5 phases as (Fig-2) (1) no-fusion or no-union: Coral like appearance of medial articular surface (10 – 13 years), (2) beginning union: Flake commencing fusion, less than 50% of medial articular surface covered by flake (14 -16 years), (3) active union: Greater than 50% of the medial articular surface is covered by flake (17 -18 years), (4) recent with a scar: Visible gap between epiphyseal flake and bone surface (nodule like)(19 -22 years) and (5) complete fusion: Smooth appearance of medial articular surface with no scar (>24 years).

Radiographs were made with a Hewlitt-Packard Faxitron series 4305N cabinet X-ray system at 50kvp and 1.8 minutes exposure time. Film- tube distance was 60 cm was used. All plates were developed in the same automatic processor.

Age Determination by Visual Seriation of Radiographs

The age was assigned on the basis of individual rank in sequence based on the trabecular involution method [9] the radiographs were seriated with visual inspection on the basis of relative radiolucency. A final age is assigned to each radiograph. The bones were categorised based on the radiographic standards developed by Walker and Owen (1985) [9] into following eight stages.

Stage 1 (18 – 24 years)

Major part of the posterior cortex is thick and finegrained. Complete medullary cavity is filled with dense trabeculae which are aligned in the form of parallel plate in the vein of layers. The medial and lateral metaphyses are filled with fine-grained trabeculae.

Stage 2 (25 – 29 years)

Posterior cortex shows coarsening trabeculae in medullary cavity, minor disintegration of metaphyses with fewer trabeculae which are moderately grained. Anterior cortex exhibits increased trabecularization.

Stage 3 (30 – 34 years)

Increased evacuation of epiphyses with moderately grained and fewer trabeculae. Minor thinning of posterior cortex without scalloping. Medullary cavity is filled with trabeculae but the parallel plate arrangement of trabeculae is lost.

Stage 4 (35 – 39 years)

Prominent reduction of posterior cortex is seen, including medial and lateral ends. Trabecular fibres exhibit more coarsening with constant evacuation of metaphysic with increased transparency.

Stage 5 (40 – 44 years)

Increased lumen of medullary cavity. Trabecularization is more evident with coarse trabecular fibres at sternal and lateral ends. Significant thinning of anterior and posterior cortex is demonstrated.

Stage 6 (45 – 49 years)

Gradual bone loss with generalized increased translucency.

Stage 7 (50 – 54 years)

The characteristic feature of this phase is the

trabeculae are thicker and coarse. There is demonstrable bone loss but with no evacuation of medullary cavity.

Stage 8 (>55 years)

Seriation is analogous with stage 7 with more trabecularization and translucency with reduced cortex and trabeculae nearing to cortical shell condition. No evidence of trabeculae at medial and lateral ends.

Statistical Analysis

The obtained measurements of parameters were tabulated and subjected to statistical analysis using SPSS 16 version. The resultant values were analyzed using student's paired t test and chi-square analysis appropriately.

Results

The mean difference of length of the right clavicles between male and female was 10.38mm and of the left clavicles was 13.13mm. The mean difference of mid shaft circumference (MSC) between male and female clavicles on the right side was 3.9mm and on the left side was 5.8mm. The difference in mean of Robustness Index (RI) among male and female clavicles was 0.88 on right side and 1.74 on left side. The mean difference of weight of the bones on right and left side was 4.23gm and 5.44gm.

The percentage of occurrence of rhomboid fossa in male clavicles was 96% and in female clavicles was 76%. The mean difference in length and breadth of rhomboid fossa on right side was 6.73mm and 2.93mm and on the left side was 6.17mm and 4.03mm respectively. The mean difference of Index of rhomboid fossa was 6.86 on the right side and 14.07 on the left side (Table 1&2). The result of comparison of occurrence and nature of rhomboid fossa (elevated, depressed, flat, absent) between male and female clavicles with the chi-square analysis was found to be highly significant with the p – value as 0.0001. (Table 3)

Estimation of age with the appearance of medial articular surface as: Coral (10-13years) [11.5%], Flake (<50%) (14-16 years) [5.38%], Flake (>50%)(17-18 years)[6.15%], Nodule (19-22 years) [7.69%], Smooth (above 25 years) [69.23%]. (Table 4)

Estimation of age of clavicle based on its observation of X-rays by visual seriation (Walker and Owen, 1985)[9] was as follows – below 18 years (11.53%), 18-24 years (3.07%), 25-29 years (6.92%), 30-34 years (9.23%), 35-39 years (11.53%), 40-44 years (10.76%), 45-49 years (13.07%), 50-55 years (9.3%), above 55 years (24.61%) (Table-5).

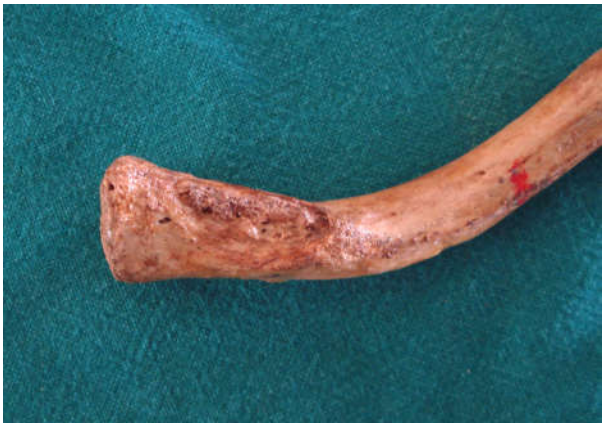

Fig. 1: Rhomboid fossa–maximum length (red) and breadth (blue)

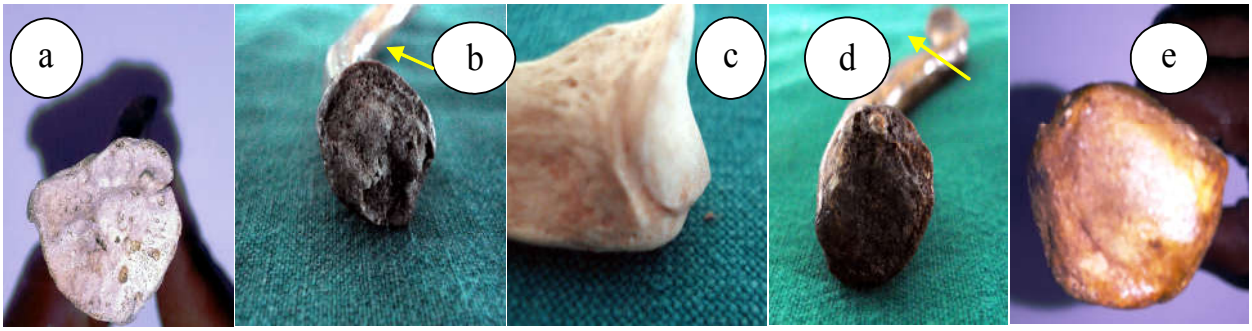

Fig. 2: External appearance of medial articulating surface to determine the age

a. Coral like appearance (no-fusion or no-union)

b. Flake commencing fusion (<50% of medial articular surface covered by flake)

c. Active union (>50% of the medial articular surface is covered by flake)

d. Recent union with a scar (nodule like)

e. Complete fusion (Smooth appearance of medial articular surface with no scar)

Table 1: Comparision of various parameters of male and female clavicles of right side

SI.NO	Parameters	Male N=30	Female N=23	SD Male	SD Female	Mean Difference	t value	P value
1	Length(mm)	137.99	127.6	9.34	9.4	10.38	3.99	0.0002 HS
2	MSC(mm)	38.34	34.35	3.66	3.97	3.99	3.78	0.0004 HS
3	Robustness Index(RI)	27.84	26.96	3.09	2.72	0.88	1.09	0.2798 NS
4	Weight(gm)	16.45	12.22	4.28	3.419	4.237	3.884	0.0003 HS
5	RF Length(mm)	19.12	12.37	5.44	7.5	6.73	3.79	0.0004 HS
6	RF Breadth(mm)	9.26	6.12	2.95	3.94	2.93	3.098	0.003 HS
7	IRF	47.07	40.2	14.71	22.61	6.86	1.33	0.1874 NS

MSC- Mid shaft circumference RF-Rhomboid fossa
IRF- Index of Rhomboid fossa NS- Not significant
HS-Highly significant S- Significant
SD- Standard deviation

Table 2: Comparision of various parameters of male and female clavicles of left side

S. No	Parameters (mean)	Male N=23	Female N=32	SD Male	SD Female	Mean Difference	t value	p value
1	Length(mm)	142.21	129.19	9.99	11.119	13.019	4.46	0.0002HS
2	MSC(mm)	39.48	33.68	3.66	3.24	5.799	6.194	0.0001HS
3	Robustness Index(RI)	27.87	26.12	2.83	2.43	1.754	2.46	0.0171S
4	Weight(gm)	16.2	10.75	4.294	3.326	5.44	5.298	0.0001HS
5	RF Length(mm)	17.47	11.3	5.47	7.066	6.1711	3.498	0.001HS
6	RF Breadth(mm)	9.14	5.15	3.179	3.138	4.0319	4.673	0.0001HS
7	IRF	50.59	36.49	15.08	21.281	14.07	2.712	0.009S

MSC- Mid shaft circumference RF-Rhomboid fossa
IRF- Index of Rhomboid fossa NS- Not significant
HS-Highly significant S- Significant
SD- Standard deviation

Table 3: Comparision of nature of rhomboid fossa of male and female clavicles

S. No	Nature of RF	Male Total:52	Female Total:56	Chi-square value	P-value
1	Elevated	14	16	22.47	0.0001
2	Depressed	27	14		
3	Flat	9	13		
4	Absent	2	13		

RF- rhomboid fossa

Table 4: Mean length of clavicle in the two sexes in population with different ethinicity as compared to the present study

Population	No. of cases		Mean length (in mm) males		Mean length (in mm) females	
	Male	Female	Right	Left	Right	Left
English (Parsons, 1916)	50	50	152	154	138	139
French (Olivier, 1951)	110	60	154.2	155	137.9	138.7
USA whites (Singh, 1969)	230		151.40	153.37	133.68	134.84
USA Negroes (Singh, 1969)	80		155.72	157.32	137.60	140.80
North west Indians(Kaur, 2002)	748	252	149.40±8.91	151.14±8.72	134.53±9.68	136.21±9.64
Gujarat (Patel,2009)	107	109	141.85±9.5	142.3±9.98	125.9±7.4	126.88±8.86
Telangana region (Ashish, 2014)			138.71±8.66	137.83±7.99	-----	------
Present study	53	55	137.99±9.34	142.21±9.99	127.6±9.4	129.19±11.11

Table 5: Occurrence of rhomboid fossa (RF) in both sexes of different regions

Origin/ Region	Occurrence of RF (%)		Reference
	Male	Female	
Northwest India	72	70	Kaur and Jit (2002)
North India	94	86	Jagmender and Dalbir (2009)
Australia	100	97	Ray(1959)
Brazil	63.6	2.9	Prado, et. al (2009)
America	33.5	5.5	Rogers, et. al (2000)
Present study	96	76	-------

Discussion

Length of the Clavicle

In present study the difference in length of male and female on both right and left side was found to be statistically highly significant (p value - 0.0002). The mean length of right and left sided clavicles in males were 137.99 ± 9.34 and 142.21 ± 9.99 and the mean length of female clavicles from right and left side were127.6±9.4 and 129.19±11.11 correspondingly. This shows that the length of right clavicle was slightly less than that of the left clavicle among both the sexes (Table 1, 2). When we compared the values of mean length of clavicle in present study with the values of different ethnic group from different population, the values of the present study were less than the previous studies (Table 4) [10,11,12,13]. This proves that there is a morphological variation of length of clavicle in present study when compared with different population. But the values of present study (Tami Nadu population) were almost similar with Gujarat and Telangana population [14,15].

Mid Shaft Circumference (MSC)

Mid shaft circumference is considered as a reliable indicator in sexing human clavicles with the combination of other parameters[16]. In a study conducted in Karnataka the mean values of MSC of male clavicles was 43 mm; female clavicles was 30 mm[7]. In present study the difference in MSC measurements among male and female clavicles statistically highly significant on both sides having mean values in right male and female clavicles were 38.34±3.66 mm; 34.35±3.97 mm respectively. The mean MSC values on left male and female clavicles were 39.48±3.66 mm; 33.68±5.7 mm. There was no much difference was observed in mean values of mid shaft circumference among right and left clavicles in both the sexes.

Robustness Index(RI)

In present study the mean values of Robustness Index also known as length circumference index was found to be not statistically significant among male and female clavicle.

Weight

Weight of the clavicle exhibited a statistical significance between male and female clavicles on both right and left side. In present study the mean weight of male and female right clavicle was 16.45±4.28 gm and 12.22±3.41gm respectively. The mean weight of male and female left clavicle was 16.2±4.29 gm and 10.75±3.32 gm respectively. The mean weight of the clavicles in both males and females was low when compared with the previous studies by Jit and Sahani (1972) [17] and Singh and Gangrade (1968) [17] which were carried out in North part of India (Table 7). As the present study was conducted in Tamil Nadu the above observation proves that the Indians belong to South part of India has less weight clavicles than North Indians.

Rhomboid Fossa (RF)

Rhomboid fossa is a costal impression situated near sternal end and gives attachment to costo-clavicular ligament. It is considered as sex and age estimator of unknown individuals [19]. The present study was conducted to evaluate the occurrence, the nature and the dimensions of rhomboid fossa. In present study the incidence of RF in males was 96% and in females was 76% which shows the occurrence of RF in males is more common than in females. Based on the nature of RF the clavicles were categorised into four groups [20] (Table 3). The chi-square analysis results were found to be significant with the p value as 0.0001. The results were similar with the previous Indian studies (Table 5) which exhibited similar percentage of occurrence of RF. But, the occurrence of RF in Americans was very less that is 33.5% in males and 5.5% in females [19]. The dimensions of RF like length and breadth shown and significant difference between male and female values on both right and left clavicles (Table 1&2). But, Index of RF was statistically not significant different between male and female values.

Estimation of Age By External Appearance of Medial Articulating Surface

Clavicle is considered as one of the age indicator bone during adolescent age [23]. Based on the study of Mckern and Stewart in Americans the commencement of epiphyseal fusion of medial end of clavicle occurs at the age of 18years [8]. Shirley and Richard in 2009 shown that the fusion of epiphysis begins at the age of 16 year old in European Americans [24]. In Japanese fusion begins at the age of 13 years [25]. In South-eastern Europeans (Bosnians) the clavicle starts its fusion one to three years earlier to Americans [26]. As there were no previous Indian studies for the assessment of age by the external appearance of articulating surface of medial end, based on the guidelines of previous studies in present study the medial end of clavicle starts union at the

age of 14 years and ossification gets completed by the age of 24 years.

Estimation of Age With Help of Visual Seriation of Radiographs (X-Rays)

Several previous studies were performed on estimation of age of an individual based on the stage of ossification of clavicle, but these studies limits up to the age of 25 years, as the ossification of clavicle gets completed by the age of 25 years. Determining age of an adult clavicle becomes a challenging task where the fusion of sternal end of clavicle is completed. In the present study, apart from the observation of stage of fusion [8], trabecular involution was also observed. The bones were categorised based on the Radiographic standards developed by Walker and Owen (1985) [9] into eight stages. Correlations of recorded age with the age obtained from observation of radiographs, the range of age was found to be similar.

Conclusion

Morphometric and non-metric analyses of clavicle plays an important role to identify the sex and age of an unidentified individual from their skeletal remains. Parameters like length, weight, mid shaft circumference, occurrence and dimensions of rhomboid fossa were found to be statistically significant between male and female. These parameters differ racially among different populations, so the values obtained from the present study can be used as reference for South Indian population. From the present study estimation of age both from the external appearance and radiographs are very helpful in identifying the age of an unknown individual and it can be concluded that from the external appearance of medial articulating surface, the sternal end of clavicle starts union at the age of 14 years and ossification gets completed by the age of 24 years and the observations are found to be similar in radiographs. Trabecular involution method by visual seriation of radiographs can considered as a useful contrivance in determination of age of an adult clavicle.

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A Narrow Accessory Tendon in Biceps Brachii Muscle Insertion

Ghatak Surajit

Abstract

A variation in biceps brachii muscle insertion by two tendons, one common tendon and another accessory tendon, in the right upper limb of a cadaver, 55 years old Indian male, was noted. A separate muscle bundleformed by several fibres from the medial side below the middle level of the arm continued as a narrow accessory tendon. This accessory tendon was in addition to the usual common belly, and was found to continue as a narrow tendinous slip and inserted in to the medial supracondylar ridge of humerus. The main muscle belly comprised of tendons from the short and long head and continued distally to form a common tendon which was inserted on the posterior part of the radial tuberosity. This variation may be considered as one of the potential cause of the pronator syndrome looking at the close relationship with the median nerve.

Key-words: Biceps Brachii Insertion; Variation.

Introduction

As understanding and management of different upper limb disorders is hoped to be increased with enhancement of the anatomical knowledge of this muscle, interest in the variations of biceps brachii persists. Variations in the origin of biceps brachii are common. However as regards to variations related to the insertion of this muscle, not many cases have been reported [1].

Case History

Arare unilateral insertion of the biceps brachii by two tendons, one common tendon and another accessory tendon, in the right upper limb of a cadaver, 55 years old Indian male, was noted during routine dissection for undergraduates in the Anatomy department of a tertiary care teaching institution of western India. The morbidhistory of the individual and the cause of death were not known. After examining the topographic details of the muscle, length and thickness of the tendons were measured. Subsequently the muscle was photographed.

The muscle was originating from short and long head as described in any standard textbook of Anatomy and both the heads fused to form a common belly. The length of the common fleshy belly was 80 mm and thickness was 6 mm. The belly continued distally to form a common tendon. The length of the common tendon was 60 mm and the thickness was 5 mm and was inserted on the posterior aspect of the radial tuberosity. In additiona separate muscle bundle 50 mm long and 2mm thick formed by some fibres from the medial side below the level of the middle of the arm continued as a narrow accessory tendon (Figure 1). The length of the accessory tendon was 50 mm and the thickness was 1.5 mm.

This accessory tendon soon divided into two slips - the lateral slip and the medial slip (Figure 2)and both were found deep to brachial artery and median nerve (Figure 3). The lateral slip crossed the cubital fossa, merged with the fascial covering of the flexor carpi ulnaris muscle. The medial slip curved medially and was attached to the medial supra-condylar ridge of the humerus.

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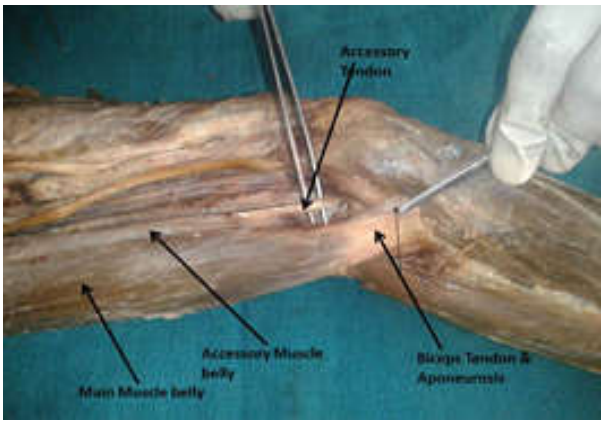

Fig. 1: Showing accessory muscle belly and accessory tendon

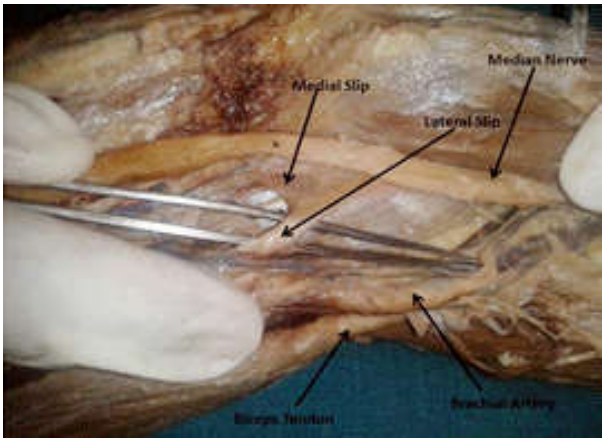

Fig. 2: Showing two slips of the accessory tendon

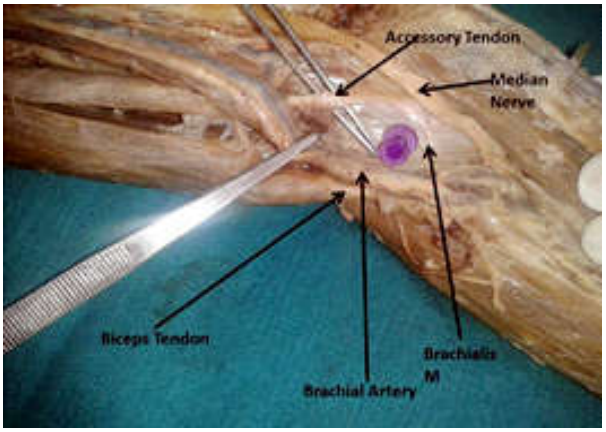

Fig. 3: Brachial artery and median nerve superficial to the accessory tendon

Discussion

Variations in the origin of biceps brachii have been reported by many workers from time to time [2, 3]. Dirim et al in 2008 in their study have reported that the distal biceps tendons are completely separated in 40 percent and bifurcated in 25 percent of cases. [4]

A case of variation in insertion of the Biceps brachii tendon similar to the observation in the present case had been described by Paval J and Mathew JG [5]. Eames M S, et. al in their study of the insertion pattern of distal biceps tendon in 17 limbs, observed that the tendon of the long head passed deep to the tendon of the short head to insert more proximally [6]. The tendon of the short head inserted in a fan like fashion into the distal portion of radial tuberosity.

The biceps brachii muscle variations can be explained phylogenetically as a remnant of a "tuberculoseptale" head present in hylobates but is a product of regression in humans and anthropoids [7]. The third head of the biceps brachii is a remnant of the long head of the coracobrachialis [8], an ancestral hominoid condition, particularly in those cases where the third head arose from the insertional area of the coracobrachialis. When the muscle primordial fails to disappear during intrauterine life, it may account for the occurrence of the accessory muscular bands [9].

In the present case study, the clinical implication of the accessory tendon reported may point to the kinematics of the biceps muscle and may have had an important role in the increased power of flexion and supination of the muscle. Further, during tendon reconstruction and repair in cases of avulsion, the comprehension of the accessory tendon of the biceps is crucial in avoiding complications. The accessory tendon of biceps brachii may also have value in flap surgery.

Moreover, subsequent to fractures, the accessory tendon can cause unusual displacement of the bone fragments [10].

The pronator syndrome was first described in 1951 by Seyffarth where the doubled bicipital aponeurosis or the lacertus fibrosus may compress the median nerve. In 17 patients suffering from median nerve entrapment, he reported that the nerve passed through the pronator teres muscle or the flexor digitorum superficialis (FDS) arch. Hence, since the initial description by Seyffarth, ambiguity exists about the name as it included more than just compression by the pronator teres[11]. Although a "spectrum" of locations of compression exists, it is still referred to as the pronator syndrome because it has a common clinical presentation.

Median nerve entrapment may occur at numerous locations considering the long and peculiar course of the median nerve. The median nerve is most vulnerable for compression at the level of the FDS arch [12] or when the nerve is passing through the pronator teres muscle [13]. In the present case, biceps brachii had an accessory muscle fasciculus which

continued as a tendinous slip. Although this variation is different from the cases of doubling of bicipital aponeurosis, this variation may also be considered as one of the potential cause of the pronator syndrome looking at the close relationship with the median nerve. However before coming to a conclusion about the presence of the popular compressive neuropathies, it is imperative toclinically evaluate the problem thoroughly.

Variations of the distal biceps brachii tendon are of clinical interest. Imaging of the distal biceps tendon is somewhat difficult due to its anatomy. An innovation in patient positioning where the patient lying prone with the arm overhead, the elbow flexed to 90°, and the forearm supinated, with the thumb pointing superiorly, has been recently described for magnetic resonance (MR) imaging of the distal biceps tendon. To describe this position the acronym FABS (*f*lexed elbow, *ab*ducted shoulder, forearm supinated) has been used [14]. The FABS position creates tension in the tendon and minimizes its obliquity and rotation, resulting in a "true" longitudinal view of the tendon. For visualization of the distal tendon and in detecting other pathologic conditions in the cubital fossa, MR imaging and, to a lesser extent, ultrasonography are useful. In the assessment of the distal biceps tendon, Imaging with FABS positioning can complement conventional MR imaging, especially in the axial plane.

Key Messages

A variation in biceps brachii muscle insertion by two tendons, one common tendon and another accessory tendon, in the right upper limb of a cadaver, 55 years old Indian male, was noted.

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