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CONTENTS

Original Article

HISTOPATHOLOGICAL AND HISTOMORPHOMETRIC STUDIES ON THE EFFECTS OF OLANZAPINE ON KIDNEY: AN EXPERIMENTAL STUDY IN ALBINO RATS

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ABSTRACT

Introduction: Olanzapine, a widely used atypical antipsychotic agent is known to cause nephrotoxic effects after prolonged use. Aim of the study was to find out detailed histopathological and histomorphometric information which might throw light on the mechanism of toxicity of olanzapine.

Material & Methods: Twelve albino rats were divided into equal number of experimental and control groups i.e. 6 each. Experimental rats received olanzapine, 4mg/kg, intraperitoneally for 6 weeks. Kidney tissue was processed for H/E stain.

Observation & Results: Extensive degenerative changes with generalized edema was observed as histopathological findings. Histomorphometry showed shrinkage of Bowman's capsule and glomeruli.

Conclusion: Degeneration of kidney due to prolonged use of olanzapine is confirmed which might be due to direct effect on the organ or indirect effect due to toxicities on other organs.

Keywords: Olanzapine, kidney, albino rats.

INTRODUCTION

Olanzapine is a widely used atypical antipsychotic agent, approved by the U.S. Food and Drug Administration for bipolar disorder and schizophrenia [1]. Olanzapine is a newer atypical antipsychotic agent with a pharmacological profile very similar to that of clozapine [2]. In human brain tissue, olanzapine exhibits very high affinity for the H1 histamine receptors and 5-HT 2A and 5-HT 2C receptors [3]. It also shows affinity for D2 receptors, muscarinic and alpha 1 receptors with lower affinity for alpha 2, 5-HT 1D and 5-HT1A receptors [3]. Such affinity pose danger to wide range of organs in the body.

Urogenital system has attracted special attention from most of the scientists because of its direct impact on fertility. Nephrotoxic effects of chronically administered olanzapine in male rats was reported by Gulec et. al. (2012) [4]. Acute kidney injury (AKI; a rapid decline in kidney function) has been attributed to atypical antipsychotic drugs in several case reports [5,6]. Marked elevations of serum CK [7-10] and urinary incontinence [11,12] as side effects of olanzapine have been well reported. Despite of extensive exploration on nephrotoxic effects of olanzapine, scientists couldn't fully ascertain the mechanism of action and suggested further investigations. Detailed histopathological and histomorphometric studies of effects of olanzapine on kidney are lacking in literature. Such informations are directly related to the affinity of drug to these organs which might throw light in finding the mechanism of action.

MATERIAL AND METHODS

Twelve male albino rats (Rattus Norwegicus) weighing around 180-200 gm were divided into equal number of experimental and control groups i.e. 6 each. Rats have ready access to water ad-libitum and standard pellet laboratory diet (Lipton India Limited). Olanzapine (inj. Oleanz, Sun Pharmaceuticals, Mumbai, India) was

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injected daily intraperitoneally in experimental rats at a dose of 4mg/kg for 6 weeks. Control group received same volume of normal saline, daily, intraperitoneally for the same period. After proposed experimental duration of 6 weeks exposure, the animals of both the experimental and control groups were anaesthetized by giving injection Nembutol (30 mg/kg), intraperitoneally. The heart was exposed by thoracotomy. The needle of the blood transfusion set was introduced into the left ventricle (apex) and a nick was made in the right atrium. After saline wash, Karnovsky's fixative was infused till the body showed signs of fixation.

A midline abdominal incision was made to identify and dissect the kidney (Fig. 1). Tissue was processed by wax embedding technique. 10µm thick sections of both experimental and control kidneys were stained with haematoxylin and eosin.

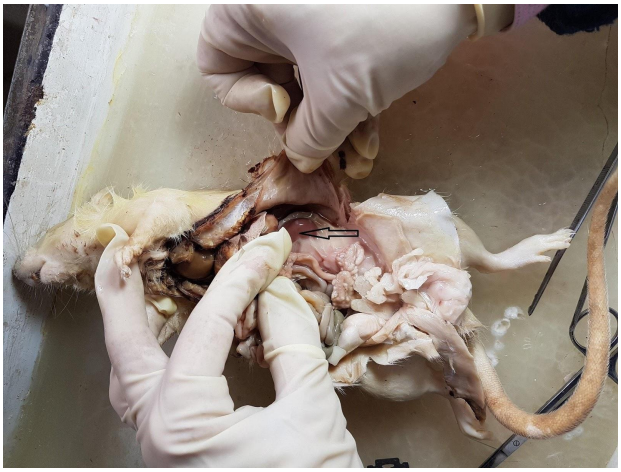

Fig. 1: Photograph of dissection showing exposed left kidney (arrow) of male albino rat

After thorough histopathological observations, histomorphometry was done in glomerulus, Bowman's capsule, proximal and distal convoluted tubules to find out any enlargement or shrinkage. Diameters measured were always external and in two directions to get mean values for the purpose of accuracy.

OBSERVATIONS AND RESULTS

Histopathology

Photomicrograph of control kidney cortex showed Bowman's capsule, glomeruli made up of bunch of patent capillaries and nuclei (around 30 in number) representing epithelial, endothelial and mesenchymal cells. Urinary spaces were clear. Tubules were lined by single layer of cuboidal cells with clear lumina. Visceral epithelium, mesangial and endothelial cells were seen in capillary tuft. Flat cells of parietal epithelium line the outer border of urinary space. A small distal convoluted tubule with prominent nuclei close together is part of juxtaglomerular apparatus were seen adjacent to glomerulus (Fig. 2).

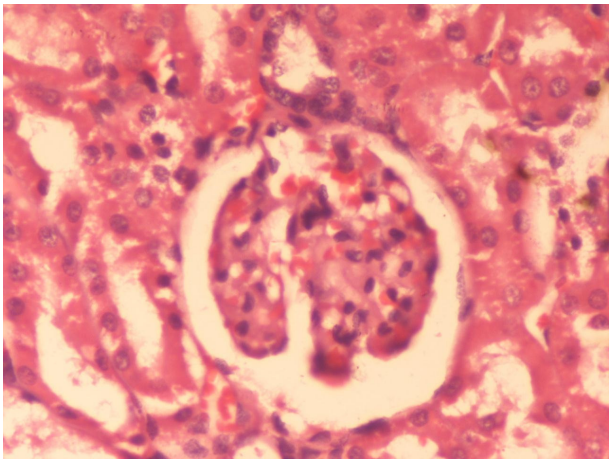

Fig. 2: Photomicrograph of control kidney: Glomerulus showing Bowman's capsule and afferent arteriole entering the capillary tuft. Visceral epithelium, mesangial and endothelial cells seen in capillary tuft. Flat cells of parietal epithelium line the outer border of urinary space. A small DCT with prominent nuclei close together is part of JGA seen adjacent to glomerulus. Tubules lined by cuboidal epithelium showing round nuclei and eosinophilic cytoplasm. Urinary space and tubule lumina are clear (H&E, 40X)

Experimental kidney glomeruli showed edema and swollen capillary tuft, increased number of nuclei, hemorrhage, acute inflammatory cells and dilated capillaries. Tubules also showed edema and wide open lumina. Around 50 nuclei were seen in glomeruli. Albumin, fibrin and blood cells were seen in urinary spaces and tubules. Arterioles were dilated. There was proliferation of mesangial cells and swelling of both parietal and visceral epithelial cells of Bowman's capsule. Denudation of parietal epithelium cells from basement membrane was also seen (Fig. 3). The proximal convoluted tubules were lined by degenerating cuboidal cells with highly eosinophilic cytoplasm and wisps of cytoplasm projecting in lumina (Fig. 4).

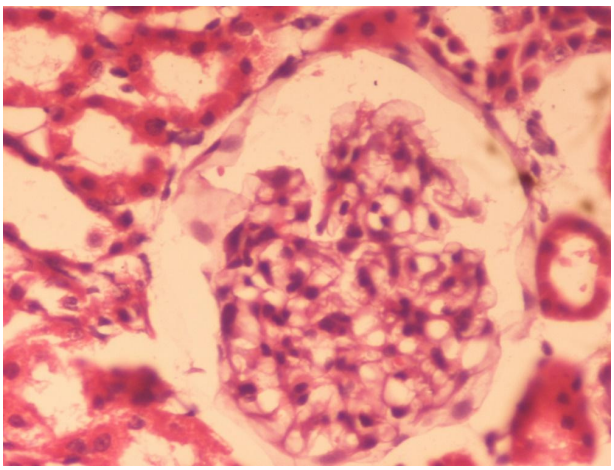

Fig. 3: Photomicrograph of experimental kidney: Section showing features of acute glomerulonephritis. Glomerulus is edematous and swollen, capillaries dilated and opened up, containing RBC acute inflammatory cells. Proliferation of mesangial cells and swelling of both parietal and visceral epithelial cells. Denudation of parietal epithelium cells from basement membrane also seen. Urinary space contains RBC's, albuminous fluid and WBC's. Tubular lumina show albumin and blood (H&E, 40X)

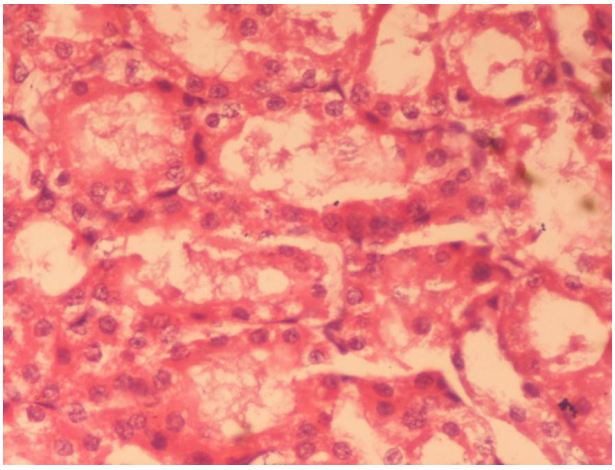

Fig. 4: Photomicrograph of experimental kidney: The PCT are lined by degenerating cuboidal cells showing highly eosinophilic cytoplasm and wisps of cytoplasm projecting in lumina. Lumen contains albumin, fibrin threads, RBC's and WBC's (H&E, 40X)

Histomorphometry

Diameter of Bowman's capsule, glomerulus, proximal and distal convoluted tubules of control and experimental groups were compared and all the values were observed to be less in experimental group as compared to control group. The diameter of Bowman's capsule and glomerulus were also statistically significant (Table 1).

Table 1: Different measurements of kidney of control and experimental rats

Diameter (µm)	Control (Mean ± SD)	Experimental (Mean ± SD)	Percent change
Bowman's capsule	127.14 ± 16.29	103.66 ± 22.82****	□18.47
Glomerulus	95.95 ±14.61	82.29 ± 22.297***	□14.24
Proximal convoluted tubules	42.41 ± 7.13	37.698 ± 7.67^{NS}	□11.11
Distal convoluted tubules	34.921 ± 4.164	31.349 ± 3.583^{NS}	□10.23

p value ****<0.001, ***<0.01, **<0.02, ^{NS} Not significant

DISCUSSION

Degenerative changes are well marked in our experimental kidney in the form of glomerular edema and swollen capillary tufts, increased number of nuclei, haemorrhage and acute inflammatory cells and dilated capillaries. In a similar study Gulec et al, (2012) [4] reported focal necrosis in some areas of renal cortex and medulla after olanzapine intoxication in rats. The only difference between the aforesaid findings and our observations is that the former found degeneration in some areas only but ours is a generalized effect. It is interesting to note that in both the cases there is great affinity of the drug for parietal layer of Bowman's capsule.

Gulec et al. (2012) [4] found its basal lamina excessively thickened and we found excessive swelling of both parietal and visceral epithelial cells. Dilatation of arterioles and collection of large number of lymphocytes and histiocytes which infiltrate the interstitial tissue highlight excessive inflammatory process undergoing in the region of glomeruli. Such an extensive histopathological findings due to olanzapine treatment are lacking in literature. External pressure due to edema could compress the Bowman's capsule obliterating urinary space and decreasing the diameter of Bowmen's capsule as confirmed by histomorphometry.

In kidney, D2 like receptors are found in glomeruli, renal tubules and post ganglionic sympathetic nerve terminals [13]. H1 histamine receptor is present in smooth muscles, endothelium and brain [14]. Presence of muscarinic receptors are well documented in nerves, heart, smooth muscles, glands and endothelium [15]. Location of serotonergic receptors are seen as 5-HT 2A in smooth muscles, platelet and cerebral cortex; 5-HT 2C in choroid, hippocampus and substantia nigra; 5-HT 1D in brain and 5-HT1A in raphe nucleus and hippocampus [14].

Aforesaid facts may be indicative of direct toxic effect of the drug on organs considered in our experiment. At the same time, the damaging effects of olanzapine on organs under consideration may also be an indirect expression due to its direct effects on other organs of the body.

Formation of reactive oxygen species is induced by the use of olanzapine [16] which may cause cellular damage and dysfunction [17]. It has been proved that using antioxidant can reduce the metabolic changes in rats receiving olanzapine [18]. Reactive oxygen species could also be generalized reason for changes in organs under consideration. Vascular factor may be another generalized reason for the degenerative changes in all our four organs of experimental rats. But this prediction needs further experimental studies for confirmation.

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Original Article

OSTEOMETRY OF FEMUR WITH ITS CLINICAL IMPLICATIONS

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ABSTRACT

Introduction: Femur osteometry is important for establishing individual identity, designing of prosthesis for hip replacement surgeries, nail application, and determination of age and sex. Review of previous study showed a lack of extensive database. This study was undertaken to build baseline data for femur osteometry in North Indian population.

Material & Methods: One hundred and fifteen dry human femur of undetermined age and gender were collected for this study. Parameters namely length of femur, vertical diameter of head, transverse diameter of head, epicondylar breadth and neck shaft angle were measured using a vernier calliper. Data was analysed statistically using SPSS 19 software.

Results: The mean values for length, vertical diameter head, transverse diameter head , epicondylar breadth and neck shaft angle were 418.16+27.34 mm, 38.43 ± 3.87mm, 35.41 ± 3.76mm, 72.06 ± 6.55mm and 121.5 º ± 6.14 respectively for the studied population.

Conclusion: Study signifies the importance of collecting ostemetric data of femur for a specific population due to ethnic and environmental factors affecting it.

Keywords: Femur, osteometry, vertical diameter head, transverse diameter head, epicondylar breadth, neck shaft angle.

INTRODUCTION

Femur is the strongest and longest bone of human body. A comprehensive insight into physical characteristics of bone helps forensic anthropologist to provide information on slight distinctions in human skeleton that are helpful in finding individual identity [1]. Apart from identification of an individual, it can be used for trauma analysis, photographic superimposition, and to determine time interval since death of an individual [2].

Fracture of neck of femur and hip joint dislocation is commonly seen in clinical practice. Data of diameter of the head and neck of the femur is crucial in orthopaedic surgery in prosthesis and nail application. It is required in radiology to determine age and recognise bone pathology. The femoral normative values can be used by plastic and reconstructive surgeons in their reconstruction and medical rehabilitation [3].

In forensic osteology, finding of sex from skeletal remains is of utmost value and depends largely on data techniques to give precise information. In addition, long bones either singly or jointly are used for determining sex [4].

The hard composition of femur makes it the ideal bone to be preserved for forensic examination [5].

When previous literature was reviewed, it was found that there was lack of an extensive database in North Indian population. Since the morphometric measurements vary with sex, age, race, ethnicity, climate and other geographical factors, regional variation is found in dimensions [6], hence this study

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was undertaken to study and analyse the various dimensions of femur in North Indian population.

MATERIAL AND METHODS

One hundred and fifteen (Right=58, Left=57) adult dry human femurs of unknown gender were collected from bone bank of Department of Anatomy, University College of Medical Sciences, Delhi and Heritage Institute of Medical Sciences, Varanasi. Unossified, deformed and fractured bones were excluded from the present study. Materials required for the study were osteometric board, digital vernier calliper, thread, clay, angle measuring protractor, measuring scale, tape and marker pencils

The following dimensions were measured [7]:

Length of femur (ML) (Fig. 1 A):

In anatomical position, the highest point on the head was identified and marked as point a and a line drawn from highest point in coronal plane wherever it cut the lower extreme articular margin of the lower end of femur was taken as point b. The distance between points a and b were measured using a measuring tape.

Vertical diameter of head (VDH) (Fig. 1 B):

The maximum diameter of head in vertical plane was measured by using a digital vernier calliper.

Transverse diameter of head (TDH) (Fig. 1 C):

The maximum diameter of head in transverse plane taken at right angle to vertical diameter by using a digital vernier calliper.

Epicondylar breadth (ECB) (Fig. 2 A):

The distance between the most projected points on the epicondyles was measured using a digital vernier calliper.

Neck shaft angle (NSA) (Fig. 2 B):

The angle made by axis of shaft with the axis of the upper anterior column. Axis of column is computed by using a thread which divides the anterior surface of the column in two equal halves. Axis of the shaft is computed by a thread which spreads in the mid sagittal plane over the anterior surface of the bone from the upper end of the oblique line stretching between the condyles.

Statistical analysis: The data was measured in millimetre (mm), tabulated and analysed using SPSS 19 software. The results were compared accordingly. The level of significance was marked at $p<0.05$ at 95% confidence interval.

Fig 1: Photograph showing measurement of: A. Length of femur (ab), B. Vertical diameter of head, C. Transverse diameter of head

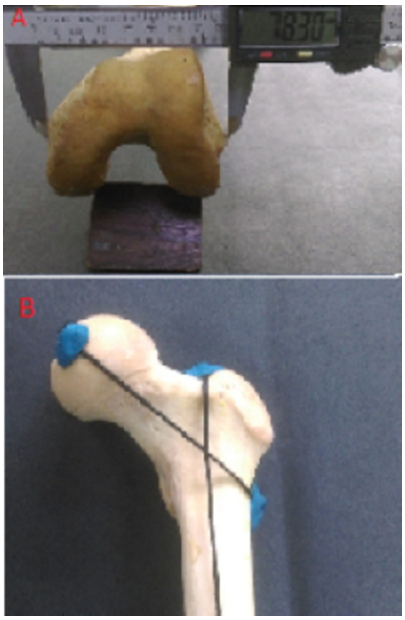

Fig 2: Photograph showing measurement of: A. Epicondylar breadth B. Neck Shaft angle

OBSERVATION AND RESULTS

Average length of femur was 418.16+27.34 mm with mean left side length as 420.23+26 mm and mean right side length as 416.13+28 mm. The average mean vertical diameter of head was 38.43 ± 3.87mm, mean right transverse diameter of head was 38.17 ± 3.76mm and left was 38.7 ± 4 mms The average mean transverse diameter of head was 35.41 ± 3.76mm, mean right transverse diameter of head was 35.53 ± 3.68mm and left was 35.37 ± 3.83mms. The average mean epicondylar breadth was 72.06 ± 6.55mm with mean right epicondylar breadth as 72.48 ± 6.38 mm and left as 71.63+6.75mm. The average mean neck shaft angle was 121.5 ± 6.14°, mean right neck shaft angle was 119.37 ± 4.52 and left was 123.7 ± 6.7 (Fig. 3 & 4).

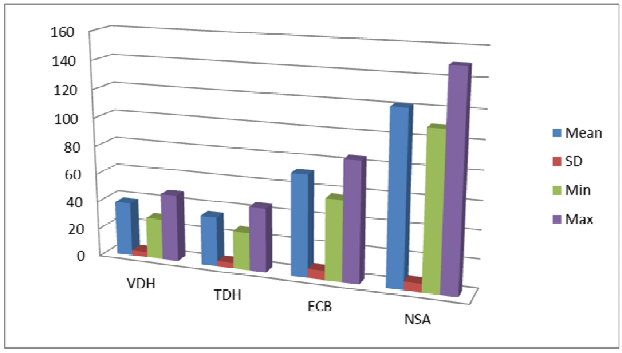

Fig. 3: Bar diagram showing mean, standard deviation, minimum and maximum values for various parameters (VDH: vertical diameter of head, TDH: transverse diameter of head, ECB: epicondylar breadth, NSA: neck shaft angle)

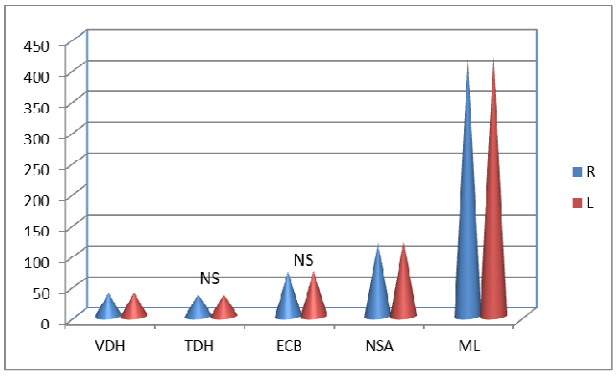

Fig. 4: Comparison of femur parameters on right and left sides

DISCUSSION

The present study was an attempt to construct data on different dimensions of adult femur in North Indian population. When osteometric data of various dimensions of femur was compared with other racial groups (Asian, African and Turkish), it was found that mean values of ML, VDH, TDH, ECB and NSA were 418.16+27.34 mm, 38.43 ± 3.87mm, 35.41 ± 3.76mm, 72.06 ± 6.55mm and 121.5 ± 6.14° respectively in our study and were statistically significant ($p<0.05$) [8-10] (Table 1).

On an average, mean value of all parameters in our study were found to be lower when compared with African, Turkish and Asian groups [8-10] (Fig. **5**).

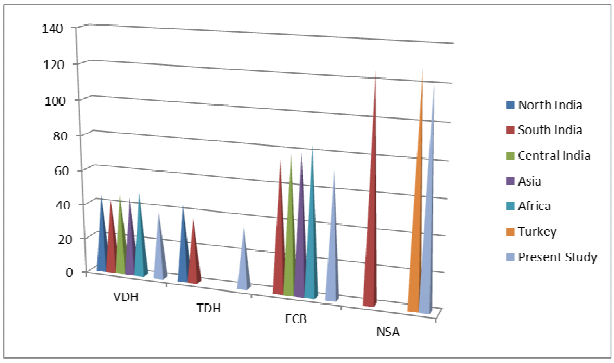

Fig. 5: Comparing mean values of various femoral parameters from across the world

Data from various Indian origin population groups were used for regional comparison. Most of the parameters like ML, VDH, ECB and NSA were variable as far as statistical significant difference was concerned [5, 11-13]. Difference was statistically significant with respect to these parameters when data from present study was compared with that from central and North Indian population. However, the difference was statistically non-significant for these parameters when compared with South Indian studies [5,12] (Table 1).

VDH was the only parameter which showed statistically significant difference amongst various population groups. Both regional and racial variations were found [5, 8-13] (Table 1). The variability in this parameter should be particularly kept in mind when designing prosthesis for specific population groups to ensure better treatment outcomes.

The knowledge about different diameter of the head and neck of the femur is essential in orthopedic

surgery in prosthesis and nail application. This is helpful in radiological practice in recognising pathology of bone and for determination of age [3].

Data of femoral head from both sexes is required for structuring of prosthesis used in hip replacement surgery [14]. Sex can determined concretely by discriminant function analysis and can be estimated by 85% accuracy in case of vertical diameter and 81.7% in case of transverse diameter [12,15].

As explained above, osteometric measurement of femur can be used extensively in anatomy, forensic science, radiology, orthopedic surgery, and structuring of prosthesis of femoral head [16]. To the best of our knowledge no other Indian study has collected and analysed such an extensive database, considering the fact that our sample size was largest and several parameters were measured. This study will effectively contribute to build an elaborate baseline data for North Indian population.

Table 1: Comparison of various parameters between various population groups

Parameter	Authors	Region	Sample number	Mean (mm)	´p´ value	Significance Level
Length	Pillai et al. (2014)	India South	50	437±31	0.001	NS
	Purkait & Chandra (2014)	India Central	80	450±21	<0.0001	S
	Steyn & Iscan (1997)	Africa	56	450±27	<0.0001	S
Vertical Diameter Head	Pillai et al. (2014)	India South	50	42±3.5	<0.0001	S
	Khaleel & Shaik (2014)	India South	50	42±3.6	<0.0001	S
	Purkait & Chandra (2014)	India Central	80	46±2.3	<0.0001	S
	Pandey & Gaikwad (2016)	India North	60	44±3	<0.0001	S
	King et al. (1998)	Asia	70	45±1.9	<0.0001	S
	Steyn & Iscan (1997	Africa	56	48±2.6	<0.0001	S
	Atilla et al. (2007)	Turkey	114	45±4.1	<0.0001	S
Transverse Diameter Head	Pillai et al. (2014)	India South	50	37±3	0.0070	NS
	Pandey & Gaikwad (2016)	India North	60	44.6	<0.0001	S
Epicondylar Breadth	Pillai et al. (2014)	India South	50	75±6.0	0.0064	NS
	Purkait & Chandra (2014)	India Central	80	78±4.5	<0.0001	S
	King et al. (1998)	Asia	70	78±3.5	<0.0001	S
	Steyn & Iscan (1997)	Africa	56	84±4.6	<0.0001	S
Neck Shaft Angle	Pillai et al. (2014)	India South	50	106±6.5	<0.0001	S
	Khaleel & Shaik (2014)	India South	50	125±6.5	0.0005	NS
	Atilla et al. (2007)	Turkey	114	128±4.7	<0.0001	S

CONCLUSION

This study reinforces the importance of collecting extensive database for osteometric measurements of femur for varied population groups as they get affected by ethnic and environmental factors. This is to ensure better treatment outcomes.

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Original Article

RELATION OF MEDIAN NERVE WITH BRACHIAL ARTERY: A CADAVERIC STUDY

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ABSTRACT

Introduction: Variation in neurovascular structure are commonly encountered in routine dissection. Brachial artery is the main artery of upper limb. In the arm, the median nerve passes at first lateral to brachial artery (near the insertion of coracobrachialis muscle), then crosses in front of the artery, descending medial to it in the cubital fossa. The knowledge of these variation could be helpful to vascular, plastic, general surgeons and orthopedicians. It is also important to prevent iatrogenic injuries. The aim of this study was to evaluate anatomical variations in course and relation of median nerve to brachial artery in the arm.

Material & Methods: The study was conducted in 50 cadavers (100 upper limbs) in duration of two years. Proper cadaveric dissection was done in the Department of Anatomy, Dr. RML Institute of Medical Sciences, Lucknow, and Era's Lucknow Medical College, Lucknow.

Observation & Results: In the present series, median nerve was found to cross behind the brachial artery at about the middle of the arm in 8% cadavers. Median nerve entered the arm at first lateral to brachial artery, near the insertion of coracobrachialis. In 46 cadavers (96 upper limbs), it crossed in front of the artery from lateral to medial side. In four cadavers (5 upper limbs), it passed posterior to the brachial artery in the arm.

Conclusion: Knowledge of the brachial artery and their variations are of clinical and surgical importance. An awareness of such a presence is valuable for the surgeons and radiologists in evaluation of angiographic images, vascular and re-constructive surgery or appropriate treatment for compressive neuropathies.

Keywords: Brachial artery, median nerve, variations

INTRODUCTION

Alteration from usual course of nerve and vessels of upper limb is not uncommon finding, but it has important clinical implications. The knowledge of these variation could be helpful to vascular, plastic, general surgeons, orthopedicians and to prevent iatrogenic injuries.

The median nerve has two roots from the lateral cord (C5, 6, 7) and medial cord (C8 & T1), which embrace the third part of axillary artery and unite anterior or lateral to it. Median nerve enters the arm at first lateral to brachial artery, near the insertion of coracobrachialis it crosses in front of the artery descending medial to it in the cubital fossa without receiving any branch. It supplies most of the flexor muscles in the anterior aspect of the forearm along with muscles of thenar eminence and lateral two lumbricals [1].

Unusual course of median nerve may mislead and cause confusion in identifying it for repairing damaged median nerve and/or cause complications in other iatrogenic activities [2,3].

The brachial artery, a continuation of the axillary artery, begins at the distal (inferior) border of the

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tendon of teres major and ends about a centimetre distal to the elbow joint (at the level of the neck of the radius) by dividing into radial and ulnar arteries. At first it is medial to the humerus, but gradually spirals anterior to it until it lies midway between the humeral epicondyles. Its pulsation can be felt throughout.

The brachial artery is wholly superficial, covered anteriorly only by skin, superficial and deep fasciae. At the elbow the brachial artery sinks deeply into the triangular intermuscular cubital fossa. Artery shows wide range of variations in upper limb [4]. Accessory brachial artery was first established by Mc Cormack and embryologically it referred to as the superficial brachial artery [5]. Variations in the incidence of superficial brachial artery (0.66-1.25%) have been reported in literature [6]. Injuries of the upper limb either due to accident or surgeries or even routine procedures such as intravenous cannulation can lead to damage to these vessels. Large size superficially lying arteries provide large size pedicles for local reconstructive surgeries in the shoulder, arm and elbow region. Thus prior knowledge of such variations may be quite useful [6].

This study was done to evaluate anatomical variations in the course and relation of median nerve to brachial artery in the arm.

MATERIAL AND METHODS

The study was conducted in 50 cadavers (100 upper limbs) in duration of two years. Proper cadaveric dissection was done in the Department of Anatomy, Dr. RML Institute of Medical Sciences, Lucknow, and Era's Lucknow Medical College, Lucknow.

The arm and cubital fossa were dissected to expose brachial artery and median nerve as per Cunningham's manual [7]. The normal anatomy and variations in relation of median nerve to brachial artery was observed and photographs of the variant upper limbs were taken.

Results were compared with normal standard course and relation of median nerve with brachial artery as stated in Gray's Anatomy [1}. Distance of formation of median nerve from bony landmark namely coracoid process (proximally) was meticulously measured.

Variations were calculated in percentage with reference to total number of observations. Analysis was done by using SPAPA 11.1 version and data was presented in mean ± SD (standard deviation), frequency, percentage. In the case of categorical data, Chi square test was used. P value < .05 was taken as statistically significant.

OBSERVATIONS AND RESULTS

Median nerve and brachial artery were studied with regards to relation of median nerve at its formation with axillary artery, distance from coracoid process to formation of median nerve, and relation of median nerve to brachial artery in the arm.

Relation of median nerve at its formation with axillary artery

Formation of median nerve was seen anterior and anterolateral in 92 upper limbs and medial in 8 upper limbs in relation to third part of axillary artery (5-Right upper limbs, 3- Left upper limbs).

Distance from coracoid process to formation of median nerve

We observed that median nerve was formed in upper third of the arm at variable distance. The mean distance from the coracoid process to formation of median nerve by two roots was 4.4 ± 1.16 (varied from 2.5 to 8) cm on right side whereas it was 4.3 ± 1.44 (varied from 2.5 to 9) cm on left side. The mean distance between right and left was not statistically significant (p value=0.94). High and low formation of median nerve in the axilla was noted and photographed (Fig. 1a,b & 2a,b).

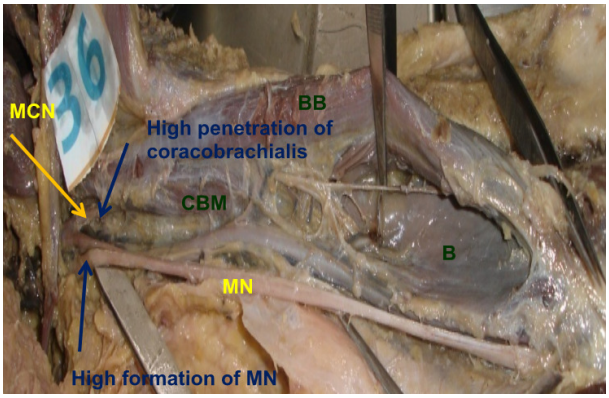

Fig. 1a: Photograph showing high formation of median nerve in left arm (MCN: Musculocutaneous nerve, MN: Median nerve, B: Brachialis, BB: Biceps brachii, CBM: Coracobrachialis)

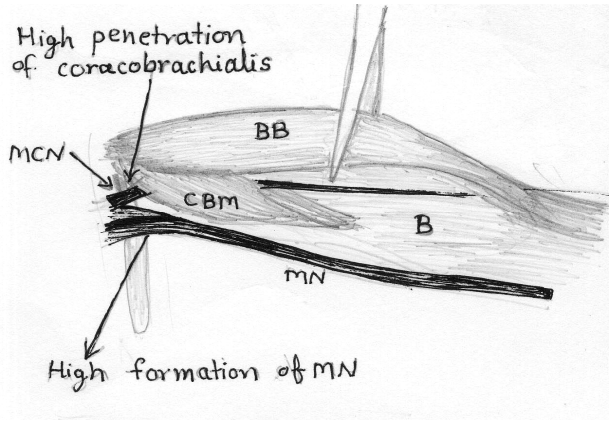

Fig. 1b: Schematic representation of Fig. 1a (MCN: Musculocutaneous nerve, MN: Median nerve, B: Brachialis, BB: Biceps brachii, CBM: Coracobrachialis)

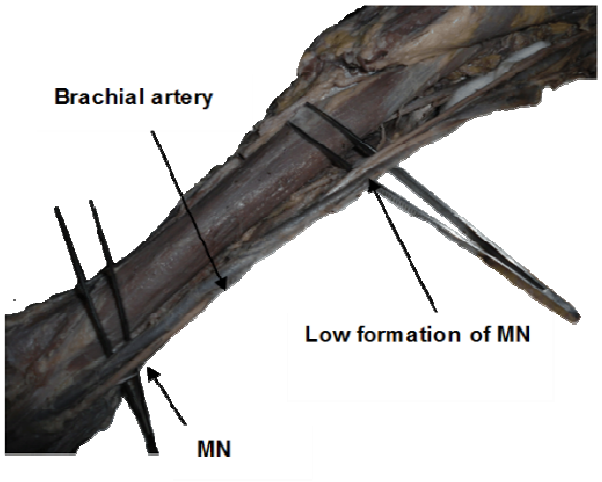

Fig. 2a: Photograph showing median nerve crossing posterior to brachial artery and low formation of median nerve (MN)

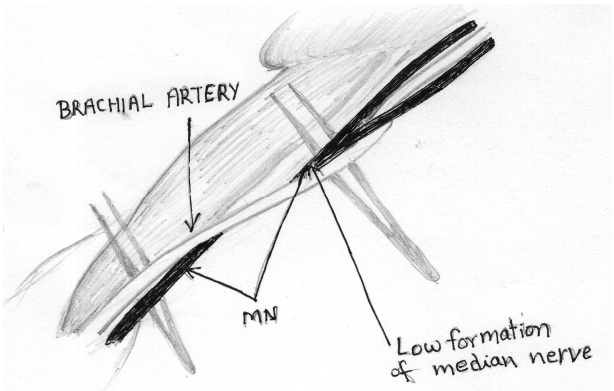

Fig. 2b: Schematic representation of Fig. 2a (MN: Median nerve) Relation of median nerve to brachial artery in the arm

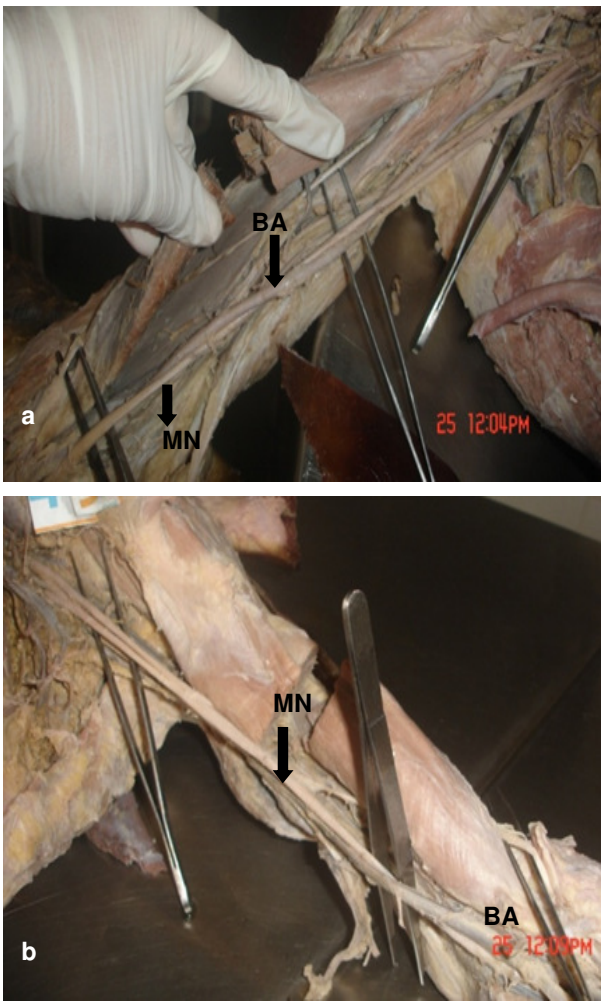

Fig. 3a&b: Arm showing median nerve crossing deep (posterior) to the brachial artery from lateral to medial side (bilaterally) (MN: Median nerve, BA: Brachial artery)

Median nerve entered the arm at first lateral to brachial artery, near the insertion of coracobrachialis it crossed in front of the artery in 46 cadavers (96 upper limbs) from lateral to medial side. In four cadavers, (5 upper limbs) it passed posterior to the brachial artery in the arm (Fig. 3a,b, Table 1).

Table 1: Relation of median nerve with brachial artery in the arm

Relation of median nerve with brachial artery in arm	Crossed anteriorly	Crossed posteriorly
No. of cadavers	46 (96 upper limbs)	4 (5 upper limbs)
Percentage	92%	8%

This variation was observed bilaterally (Fig. 3) in one and unilaterally (Fig. 2) in three cadavers. Thereafter the nerve accompanied the medial side of the artery and appeared in the cubital fossa. Median nerve left the cubital fossa between the two heads of pronator teres and appeared between the superficial and deep groups of flexor muscles of the forearm.

In one right arm, brachial artery divided high in the arm into superficial and deep branches. In this case, median nerve crossed posterior to the superficial branch of brachial artery (SBA) from lateral to medial side. Thereafter the superficial branch continued as radial artery and deep branch followed the course of ulnar artery (Fig. 4a,b).

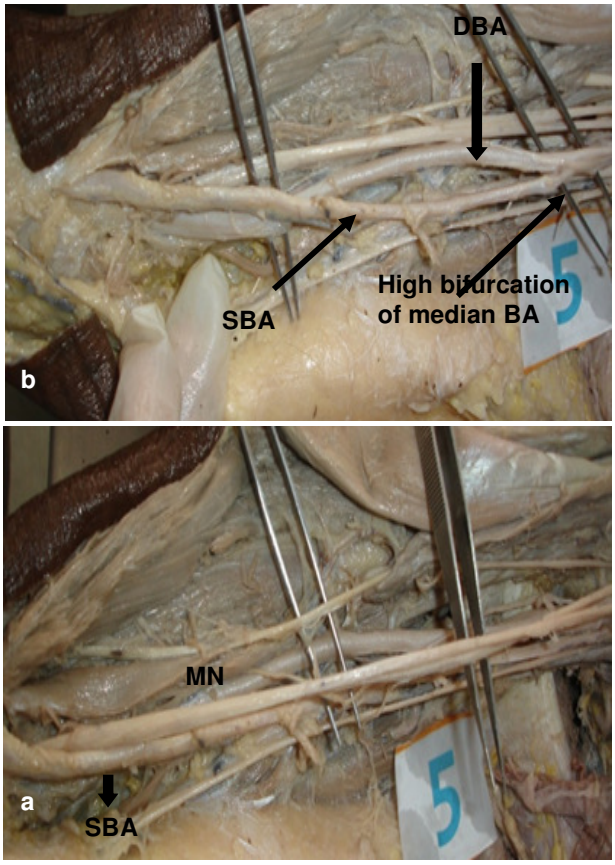

Fig. 4a&b: Right arm showing high bifurcation of brachial artery & median nerve crossing lateral to medial side behind the superficial brachial artery in lower segment of arm (MN: Median nerve, SBA: Superficial branch of brachial artery, DBA: Deep branch of brachial artery)

DISCUSSION

Relation of median nerve at its formation with axillary artery

Normally formation of median nerve takes place lateral to third part of axillary artery. Haviarova et al. (2009) [8] described a case where median nerve was formed behind the axillary artery though in our series we have not found such variation. Formation of median nerve medial to the axillary artery had been described by various authors [9-11]. In present study, median nerve formed medial to axillary artery in 4 (8%) cadavers which is slightly more than previously reported series. Pandey & Shukla (2007) observed such variation in 4.7% cases [12] whereas Bhudiraja et al. (2011) reported 6.12% cases of his series having such variation [13]. This variation is important in post-traumatic evaluation of peripheral nerves.

Distance from coracoid process to formation of median nerve

The mean distance from coracoid process to formation of median nerve by two roots was 4.4 ± 1.16 (varied from 2.5 to 8) cm on right side whereas it was 4.3 ± 1.44 (varied from 2.5 to 9) cm on left side. The median nerve is usually formed in the axilla by the union of medial and lateral roots [1]. Our results are comparable to that of Bhudiraja et al. (2011) who reported the incidence of low fusion of two roots in 17% cases though they have not described the limit for the low fusion of two roots [13]. Testut and Latarjet (cited by Jakubowicz and Ratajczak, 2000) [14] reported that the lateral root united with the medial root as low as at the level of the cubital fossa to form median nerve. Jakubowicz and Ratajczak (2000) [14] reported that the two roots of the median nerve united lower than normal. The clinical importance of such variation lies in surgical procedure and nerve block anaesthesia, because if nerve block is given proximal to the fusion of the roots effect will not be proper.

Relation of median nerve to brachial artery in the arm

In the present series, median nerve was found to cross posterior to brachial artery at about the middle of the arm in 8% cadavers (Fig. 2-4). Joshi et al. (2008) reported this variation in 4.7 % of cases [15]. Sudarshan et al. (2013) studied relation of median nerve to brachial artery in 95 upper limbs. He noted that median nerve coursed superficial to artery in 88.42% (45 right & 39 left) and deep to the artery i.e. superficial brachial artery was seen in 11.57% of limbs (6 right & 5 left) [16]. Bharti et al. (2015) in their study

on 10 cadavers noted, that in one cadaver median nerve crossed brachial artery in the arm behind instead of coming in front [17]. The brachial artery coursing in front of rather than behind the median nerve is called superficial brachial artery [16].

Most of the earlier reports of superficial brachial artery, by both large sample studies and case reports, are associated with two brachial arteries in the arm where one is superficial and the other is deep to the median nerve. Anomalies of the forelimb arteries are very common. This is because of their multiple and plexiform sources of origin, the temporal succession of emergence of principal arteries, anastomosis and periarterial network and functional dominance followed by regression of some paths [18]. Persistence of embryological vessels may be the basis of SBA. Miller believed that superficial brachial artery is an atavistic condition (retention of a primitive pattern), as the main brachial artery crossing superficial to median nerve is the usual arrangement in the primates [18]. Different studies have reported varied prevalence of superficial brachial artery.

Brachial artery, while crossing over the median nerve, can lay over it for some distance and compress the nerve. The diagnosis of this condition could be confusing because the symptoms resemble radiculopathy or carpal tunnel syndrome [19]. Also in cases of SBA, the superficial position of the artery renders it vulnerable to trauma. However when required, it is easily accessible for cannulation. Also SBA may be mistaken for a vein and accidental intra-arterial injection of drugs may result in serious consequences.

CONCLUSION

Knowledge of the median nerve, brachial artery and their variations are of clinical and surgical importance. An awareness of such a presence is valuable for the surgeons and radiologists in evaluation of angiographic images, vascular and re-constructive surgery or appropriate treatment for compressive neuropathies.

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Original Article

COGNITIVE AND NON-COGNITIVE CHARACTERISTICS PREDICTING ACADEMIC SUCCESS AMONG MEDICAL STUDENTS

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ABSTRACT

Introduction: Medical undergraduates need to possess the ability to acquire knowledge on a wide range of subjects over short period of time. Medical schools worldwide use different methodologies to select ideal candidates, which include cognitive factors and non-cognitive factors. A proper selection will minimize failures during the beginning semesters and will ensure student's capacity to withstand the standard of training. Therefore, we have decided to study the impact of cognitive and non-cognitive factors in predicting the academic success among medical students.

Material & Methods: The study was a survey of 150 first year medical students of Jawaharlal Nehru Medical College (JNMC), Aligarh Muslim University (AMU), Aligarh, admitted in 2018. A data was collected from the Department of Anatomy for initial three part completion tests performance and class attendance, which was tabulated along with the information received from the questionnaire i.e. age, gender, percent secured and language in school, National eligibility cum entrance test (NEET) attempt and marks, residence, category for premedical (PMT) selection (general/ non-resident Indians (NRIs)/ handicap), parents occupation, siblings, family (nuclear/joint/rural/urban), hobbies, time management during PC (part completion) tests, coaching before PMT) given to each student separately.

Observation & Results: Students were observed to lie in three groups according to their performance in PC tests: group I (>60%), group II (50-59.9%), group III (<50%). All the cognitive and non-cognitive factors were compared.

Conclusion: Both cognitive and non-cognitive factors play an important role in the outcome of a medical student. Factors positively influencing the performance of a selected candidate in medical schools cannot be simply based on previous academic performance.

Keywords: Academic success, cognitive factors, non-cognitive factors, selection procedure, medical students

INTRODUCTION

Medicine is a complex and demanding field of education. Medical undergraduates not only require skill and competence in multiple disciplines, they also need to possess the ability to acquire knowledge on a wide range of subjects over short period of time. Medical schools worldwide use different methodologies to select ideal candidates, which include cognitive factors like previous academic performance and non-cognitive factors like personality,

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performance at interview, comments by referees, personal statements in forms of essays and assessing the involvement in extra-curricular activities [1-3]. Social and emotional competence was believed to be considered as a determinant for academic achievement [4]. Hence emotions have consistently been seen as an essential components of learning, along with the emphasised cognitive ability [5].

The medical education system in India is one of the largest in the world. It consists of 496 medical schools, each associated with a university, producing around 64,000 doctors each year [6]. The Indian medical education system produces many physicians who emigrating to the United States, United Kingdom and several other countries. The quality of these physicians therefore, has a broad global impact. A proper selection will minimize failures during the beginning semesters and will ensure student capacity to withstand the standard of training [7]. Thus, the objective of this study was to assess the students for medical education on a wider criteria. Therefore, we have decided to study the impact of cognitive and non-cognitive factors in predicting the academic success among medical students.

MATERIAL AND METHODS

The study was a survey, performed on 150 first year medical students of JNMC, AMU, Aligarh, admitted in 2018. Afore mentioned students were informed about the survey and a questionnaire was given to each of them separately. The combined attendance and performance was collected from the Department of Anatomy for initial three part completion tests.

Cognitive factors included performance and language preferences in school, number of PMT attempts, NEET%, category for selection in (Bachelor of medicine and bachelor of surgery) MBBS, hobbies, time management of paper attempt during PC tests, preference of coaching before selection in PMT and class attendance.

The non-cognitive factors were gender, age, present residence during MBBS course, educational status of parents, information regarding siblings, family status with residence and handedness of the students.

All the information received was tabulated and analysed. No statistical methods were used in the survey. The students were divided into three groups on the basis of performance in part completion tests-

Group I- having >60% in PC tests (obtained □360 marks out of 600)

Group II- having 50-59.9% in PC tests (obtained marks between 300-359 out of 600)

Group III- having <50% (obtained <300 marks out of 600)

OBSERVATIONS AND RESULTS

High school and intermediate marks

Students who secured <75% marks in 12th class had also not performed well in PC. Most of them (n= 10,71.4%) were in group III (<50% marks), and none of these students were there in group I (>60% marks), whereas majority of the students (n=58, 42.6%) obtained good marks (50-59.9%, Group II) in PC as well who secured >75% in 12th class, and significant number of these students (n=32, 23.5%) also secured >60% marks (Group I). The relationship of academic performance with 10th boards was not found to be that strong as with class 12th (Table 1).

Medium of school, PMT attempt and NEET marks

Those who preferred English medium for schooling were 42.6% in group II (50-59.9% marks) as compared to those preferring Hindi medium who were 57.1% in group III (<50% marks), more importantly students of Hindi medium were 28.5% in group I (>60% marks) as compared to students of English medium who were 20.9% in the same group. 1st attempters were 30.3% in group I, repeaters were 46.3% in group II and repeated repeaters were 45.7% in group III, showing their maximum percentage in different groups. 40% students were in group II & 30% each were in group I & II who had >600 marks in medical entrance test. NEET marks 400-599 were found to be similar in percentage in group II and were more towards group III in the remaining students. 80% individuals remained in group III had <400 marks in medical entrance (Table 1).

PMT category, Hobbies, Time management during PC test

Only the general category students (22.5%) were in group I (>60% marks). 66.6% NRI were in group II (50-59.9%) and 80% students in handicapped category were in group III (<50% marks). Individuals who spend more time in indoor activities obtained maximum marks (28.5% in group I), whereas least marks were obtained who had outdoor hobbies (50% in group III). 44.2% students were found to be in group II who

followed time management during attempting paper in part completion tests as compared to students who did not follow time limit (45.9% in group III). Percentage was equal in group I for the same (Table 1).

PMT coaching and class attendance

Students who were coached for the entrance exam were 19.8% in group I and the students who did not take coaching were 29.1% in group I. Students who had ≥85% attendance within the duration of part completion were 38% in group I, 15.5% students were in group I who had attendance between 70-84.9%, and <70% class attendance had 73.9% students in group III (Table 1).

Table 1- Outcome of cognitive factors on performance of the students

Factors		No. of students (150 total)	Performance					
			Group I (32 students)		Group II (62 students)		Group III (56 students)	
10th	<75%	6	1	**16.6**	2	**33.3**	3	**50**
	≥ 75%	144	31	**21.5**	60	**41.6**	53	**36.8**
12th	<75%	14	0	**0**	4	**28.5**	10	**71.4**
	≥ 75%	136	32	**23.5**	58	**42.6**	46	**33.8**
Medium in school	Hindi	7	2	**28.5**	1	**14.2**	4	**57.1**
	English	143	30	**20.9**	61	**42.6**	52	**36.3**
PMT attempt	1st	33	10	**30.3**	13	**39.3**	10	**30.03**
	2nd	82	14	**17.07**	38	**46.3**	30	**36.5**
	3rd	35	8	**22.8**	11	**31.4**	16	**45.7**
NEET Marks	<200	1	0	**0**	1	**100**	0	**0**
	200-299	4	0	**0**	0	**0**	4	**100**
	300-399	0	0	**0**	0	**0**	0	**0**
	400-499	3	0	**0**	2	**66.6**	1	**33.3**
	500-599	132	29	**21.9**	55	**41.6**	48	**36.3**
	≥600	10	3	**30**	4	**40**	3	**30**
PMT category	General	142	32	**22.5**	59	**41.5**	51	**35.9**
	NRI	3	0	**0**	2	**66.6**	1	**33.3**
	Handicap	5	0	**0**	1	**20**	4	**80**
Hobbies	Outdoor	64	10	**15.6**	22	**34.3**	32	**50**
	Indoor	63	18	**28.5**	27	**42.8**	18	**28.5**
	Both	23	4	**17.3**	13	**56.5**	6	**26.08**
Followed time management during PC test	Yes	113	24	**21.2**	50	**44.2**	39	**34.5**
	No	37	8	**21.6**	12	**32.4**	17	**45.9**

Factors		No. of students (150 total)	Performance					
			Group I (32 students)		Group II (62 students)		Group III (56 students)	
Medical entrance preparation through coaching	Yes	126	25	**19.8**	53	**42**	48	**38.09**
	No	24	7	**29.1**	9	**37.5**	8	**33.3**
Class attendance	≥85%	50	19	**38**	24	**48**	7	**14**
	70-84.9%	77	12	**15.5**	33	**42.8**	32	**41.5**
	<70%	23	1	**4.3**	5	**21.7**	17	**73.9**

Non cognitive factors

Age and Gender

Female students performed better than boys throughout the PC test. 34.5% female students secured >60% (Group I) as compared to only 13.6% boys. Large number of boys (54.7%) secured <50% (Group III) whereas only 7.2% females obtained <50% marks. Students who were <20 years old performed better than candidates of >20 years of age (Table 2).

Residence and educational status of parents

Day scholars performed better than hostlers consistently. 27.2% day scholars obtained >60% marks as compared to only 19.6% hostlers. Educational status of parents also had an effect on the performance of students. 52.6% students of uneducated parents obtained <50% marks whereas only 35.1% students of educated parents obtained <50% marks (Table 2).

Siblings and nature of family

Students who had more siblings performed poorer than students who had lesser siblings. Students of nuclear family showed better results as compared to joint family. 23.7% students of nuclear family had >60% marks (Group I) as compared to only 12.5% students of joint family (Table 2).

Past residence and handedness

Urban students performed better than rural. 25% students of urban background secured >60% marks (Group I) as compared to only 13.4% of rural students. Right handed students outperformed left handed consistently (Table 2).

Table 2- Outcome of non-cognitive factors on performance of the students

Factors		No. of students 150	Performance					
			Group I (32 students)		Group II (62 students)		Group III (56 students)	
			No.	%	No.	%	No.	%
Gender	Male	95	13	**13.6**	30	**31.5**	52	**54.7**
	Female	55	19	**34.5**	32	**58.1**	4	**7.2**
Age	<20 yrs	102	22	**21.5**	48	**47.05**	32	**31.3**
	≥20 yrs	48	10	**20.8**	14	**29.1**	24	**50**
Present Residence	Hostler	117	23	**19.6**	45	**38.4**	49	**41.8**
	Day Scholar	33	9	**27.2**	17	**51.5**	7	**21.2**
Educational status of parents	Educated	131	28	**21.3**	57	**43.5**	46	**35.1**
	Non educated	19	4	**21.05**	5	**26.3**	10	**52.6**

Siblings	1	12	4	**33.3**	4	**33.3**	4	**33..3**
	2-4	112	25	**22.3**	49	**43.7**	38	**33.9**
	5-7	23	3	**13**	8	**34.7**	12	**52.1**
	≥8	3	0	**0**	1	**33.3**	2	**66.6**
Order of sibling	1st	66	10	**15.1**	33	**50**	23	**34.8**
	≥2	84	22	**26.1**	29	**34.5**	33	**39.2**
Family	Nuclear	118	28	**23.7**	51	**43.2**	39	**33.05**
	Joint	32	4	**12.5**	11	**34.3**	17	**53.1**
Home town	Urban	104	26	**25**	45	**43.2**	33	**31.7**
	Rural	46	6	**13.04**	17	**36.9**	23	**50**
Handedness	Left	11	0	**0**	6	**54.5**	5	**45.4**
	Right	139	32	**23**	56	**40.02**	51	**36.6**

DISCUSSION

Medicine is considered to be the longest and most stressful course of undergraduate study [8]. Present study is one of its own kinds in western region of Uttar Pradesh that evaluates the effects of cognitive as well as non-cognitive characteristics on medical student success or failure.

Our results suggest that past academic performance is one of the predictor of future academic success among medical students. The student's competency in English as assessed by their medium (10^{th} / 12^{th} board) was also a significant predictor of success. Students less competent in English face hurdles while learning and performing at examinations. Their poor knowledge in English also hinders them in participating in academic activities. Our results showed that students of English medium were in average category as compared to students of Hindi medium who performed poorly. Also an important observation was that more number of students of Hindi medium performed fairly as compared to students of English medium. These contradictory findings define the persistent and hardworking nature of some students from Hindi medium.

First attempters performed fairly as compared to repeaters while repeat repeaters performed further poorly. These findings are parallel to some other studies [9-11]. Therefore sessions must be taken to revise the admission criteria in medical schools. Also the students who had higher entrance marks performed well as compared to the student of low entrance marks. The number of failed students showed an increasing trend in lower entrance marks.

Indian culture had old practice of depriving education and job to many based on their caste and category. Those for reservations argued that 'merit' is an amalgam of native endowments and environmental privileges. Those kept away from environmental privileges cannot be equated with others who enjoyed it. The results from the present study support the latter view, because the low rank holders in reserved categories performed poorly as compared the general category. Also those coming from low social background or rural areas performed poorly than those of urban areas who significantly performed above average [7].

The performance was above average for those students who had inclination towards indoor hobbies and poor for the students indulging in outdoor habits. A significant number of students performed average that preferred to spend their time both indoor and outdoor. These findings cannot be generalised as there are different teaching modules and exam schedules across different institutions and courses, hence the results vary from other studies [12].

Students who had practiced time management skills revealed better academic performance in Jazan University [13] as well as in our study.

Coaching to enter medical school first attracted research attention in 2008 [14]. Those who received coaching before medical entrance subsequently show

significantly poorer academic performance compared with those who had not been coached. It suggests that high scores achieved after coaching may not represent true ability to do medicine, or that students who rely on coaching cope less well in academic environments where coaching is not appropriate [15,16]. Attendance policy always can be correlated with better academic performance [17] as good attendance of the students favoured the academic score towards higher side.

Medical schools throughout the world use a variety of criteria to select applicants for admission. These criteria attempts to assess academic performance and personal characteristics suitable for a medical career. Although evaluating academic preparation is simple, assessing personal characteristics are difficult. Non-cognitive testing has been proposed as one such method to assess personal characteristics. However 'non-cognitive' tests at present are associated with numerous questions related to their validity, reliability, fairness and cost. Therefore, before changing admission policies in medical schools by using non-cognitive tests, an open discussion among all stake holders in the admissions process is critically important [9]. Women performed better than men in a study based on clinical performance [18] which is in line with the present findings showing significant difference in poor outcome of male students as compared to females.

A study done in Canada found that learning style positively correlated with younger age at admission to medical school [19], similar to the present findings which showed better performers among students having age <20 years [9]. Day scholars were always good performers as compared to hostlers in contrast to a study done in Maharashtra showing mean score for performance more for hostler students [20].

Educational status of parents and the type of family plays a crucial role in the performance of students. Educated parents in nuclear family can provide student friendly environment to gain knowledge in different fields and impart the importance of education in more productive way. Results of a Nigerian study indicated that parental occupation level significantly influenced student's academic performance, suggesting extended educational support in form of adult literacy programmes to uneducated parents in the country [21]. Furthermore, a single child in the family can perform above average, average or below average in contrast to the 1st born child who showed a decline trend depending on the number of siblings. Some studies disfavour the family related factors to show any significance for achievements [22,23].

Although the suggesting evidence is very limited and diverse, left hander students were found to be less competent in the study highlighting a growing perception about left handed medical students to face difficulties while performing [24].

CONCLUSION

Both cognitive and non-cognitive factors play an important role in the outcome of a medical student. Factors positively influencing the performance of a selected candidate in medical schools cannot be simply based on previous academic performance.

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Original Article

MORPHOLOGICAL AND DEVELOPMENTAL STUDY OF HUMAN FETAL THYMUS GLAND IN KUMAON REGION

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ABSTRACT

Introduction: A cross sectional study was conducted to observe morphological and developmental changes occurring in thymus gland at various gestational age among human fetuses. The morphometric measurements of thymus is useful in calculating size as intrauterine growth retardation (IUGR) and cellular immune deficiency of infant is associated with a significant decrease in fetal thymic size.

Materials & Methods: This study was carried on medically aborted and stillborn fetuses (n=31; F=21, M=10), which were obtained from Dr. Sushila Tiwari Memorial Hospital, Haldwani, (Uttarakhand,) with due consent of parents. Fetuses were preserved in 10% formalin. Thymic gland was dissected out to observe its weight, length and thickness.

Results: Thymus glands were located in superior mediastinum. On gross examination, they were of greyish pink to greyish brown in colour. Most of the glands were bilobed and few were irregular in shape. There was progressive increase in all morphometric dimensions of thymus in relation to gestational age. Growth of right lobe of thymus was comparatively more than of left lobe.

Conclusion: Thymic morphometric parameters in relation to gestational age can be used as reference values in imaging studies in the prenatal and in initial perinatal stages, so we could compare the normal morphology with that of in IUGR and immune deficiency.

Keywords: Fetal thymus gland, morphology, development.

INTRODUCTION

Thymus gland currently known as one of the primary central lymphoid organ. It is well known as key regulator of immune system because it produces unique environment in which the T-cell precursors (thymocytes) undergo development, differentiation and clonal expansion received from red bone marrow.

In addition to secreting thymic hormones like thymosin, the adult thymus primes thymocytes before releasing them to periphery [1,2]. Unlike the other lymphatic organs, the thymus does not filter lymphatic fluid [3]. It appears as a bilobed triangular structure located in the anterior mediastinum, most commonly anterior to the proximal ascending aorta, the pulmonary outflow tract, and the distal superior vena cava before it enters the right atrium. Differentiation of the thymus (during radiological or surgical intervention) from other mediastinal structures, such as lymph nodes or the superior sinus of the pericardium, may be difficult. Therefore, it is important to be familiar with the location, shape, and size of the normal thymus [4].

Thymus gland develops as an epithelial outpouching from the ventral aspect of the 3rd pharyngeal pouch. It starts to descend towards mediastinum and moves caudally forming what is

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known thymo-pharyngeal complex. Inferior parathyroid also develops from 3rd pharyngeal pouch. Ventral aspect of 4th pharyngeal pouch give rise to very minor and rudimentary portion of thymic tissue [5]. Descent of heart and caudal migration of aortic sac helps in caudal migration of thymic rudiments [6].

It grows rapidly during the embryonic life and childhood and reaches its maximum size during the puberty. Thereafter, the growth stops and starts involuting gradually until the old age where the gland is often smaller than at birth [7]. The involution of the thymus gland is shown by decrease in the weight of the organ associated with atrophy of lymphoid tissue and replacement by adipose tissue [8]. A reduction in thymus function results in greater susceptibility to tumors, rheumatic disease, growth disorders and general geriatric conditions [9]. The thymus arises bilaterally from the third and fourth branchial pouches and contains elements derived from all three germinal layers. After 14-16 weeks, the thymus grows rapidly and attains its greatest weight in relation to body weight before birth (average 15g) [10]. Studies relating to morphological features and morphometric parameters of thymus gland is limited in comparison to other internal fetal organs. So, further studies on thymus will be useful for researchers.

Ectopic thymic tissue is found in 25% of the population [11]; small accessory nodules may occur in the neck representing portions which have become detached during their early descent, or the thymus may be found even more superiorly as thin strands along this path, reaching the thyroid cartilage or above. Connective tissue marking the line of descent during early development may, in some instances, run between the thymus and the parathyroids.

Measurements of thymus size appeared to be useful in young human subjects and revealed for instance, that breast fed infant had thymuses on average twice the size of those in formula fed infants [12] and that thymic size at 3 month of age was a powerful predictor of infant mortality in developing country setting [13].

MATERIAL AND METHODS

This study was conducted in Department of Anatomy, Government Medical College, Haldwani. After ethical committee approval and with due consent of parents medically aborted and stillborn normal fetuses were collected from Obstetrics & Gynaecology Department, Dr .Sushila Tiwari Memorial Hospital, Haldwani. These fetuses were preserved in 10% formalin. A sample size of n=31 (F=21, M=10) human fetuses were taken ranging from 12 to 38 weeks. The fetuses were measured for crown rump length (CRL), body weight (W), foot length (FL) and pinna length (PL) to confirm the gestational age (GA).

An anterior midline skin incision was given from symphysis menti to xiphisternum. After giving bilateral parasternal incision (resection of costal cartilage) and sternoclavicular disarticulation, thorax was opened. For complete exposure of thymus gland in its natural location for proper recording, lower part of neck was also opened.

The fetal specimen (n=31) were categorized into three groups:

- Group-I- 12 to 18 weeks (n=12)
- Group-II-19 to 26 weeks (n=10)
- Group-III- 27 to 38 weeks (n=9)

The weight of whole thymus and separate for right and left lobes were assessed in gross by electronic weighing machine. The length (l), breadth (b) and thickness (t) of whole thymus and separate for right and left lobes were measured in mm by digital Vernier calipers. Data was analyzed in excel sheet and statistical analysis was done.

OBSERVATIONS AND RESULTS

The morphometric measurements were analysed by plotting scatter diagram and bar diagram to study correlation with fetal growth. The mean weight, length and breadth of right and left lobes were measured.

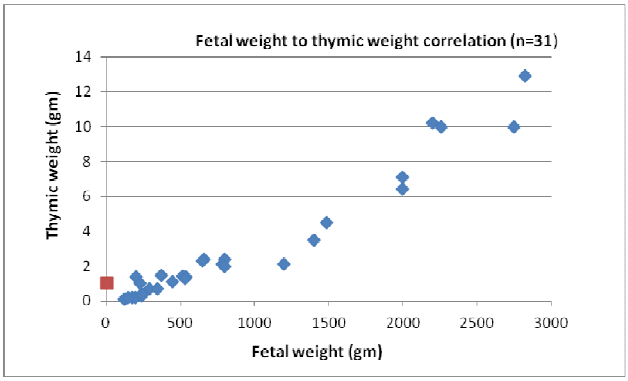

Fig. 1: Scatter diagram showing correlation between fetal and thymic weight

Correlation between fetal CRL and length of right and left lobe of thymus gland was also monitored. The maximum number of values of two variables were seen with increasing trend. Linear relationship was seen between increasing CRL and length of right and left lobes of thymus (Fig. 2&3).

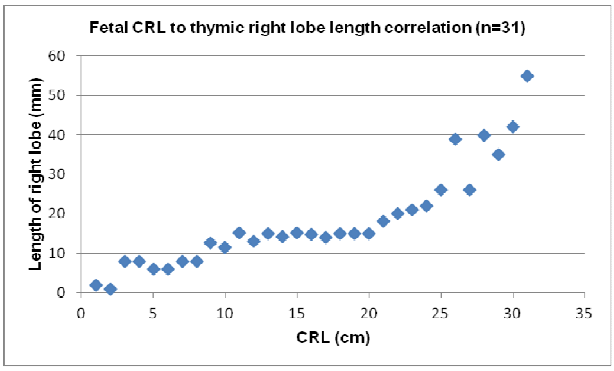

Fig. 2: Scatter diagram showing correlation between CRL and length of right lobe of thymus

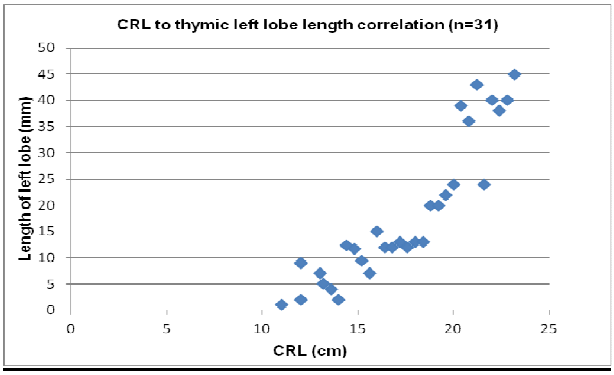

Fig. 3: Scatter diagram showing correlation between CRL and length of left lobe of thymus

The weight of thymus gland ranged from 0.1 gm to 12.9 gm. The mean of weight of thymus of group I was 0.475±0.40, group II 1.794±0.49 and group III 7.41±3.61. Comparison among mean weight of three groups was done (Fig. 4). The maximum growth was observed towards the end of gestational age.

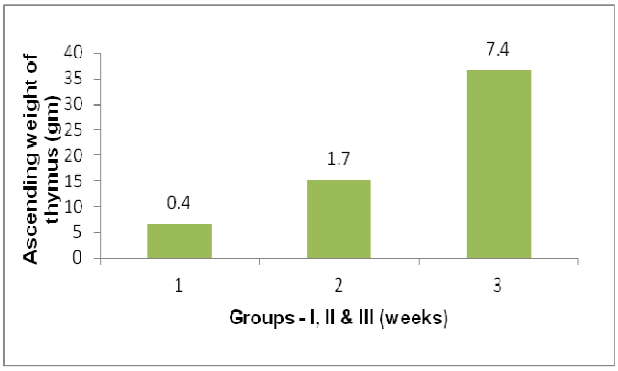

Fig. 4: Bar diagram showing comparison among mean weight of three groups

The length of right lobe of thymus gland ranged from 2 mm to 55 mm. Comparison of mean length of right lobe among three groups was evaluated i.e. group I has 8.39±4.31, group II 15.6±1.90 and group III 34±10.99 (Fig. 5). The maximum growth was observed towards the end of gestational age.

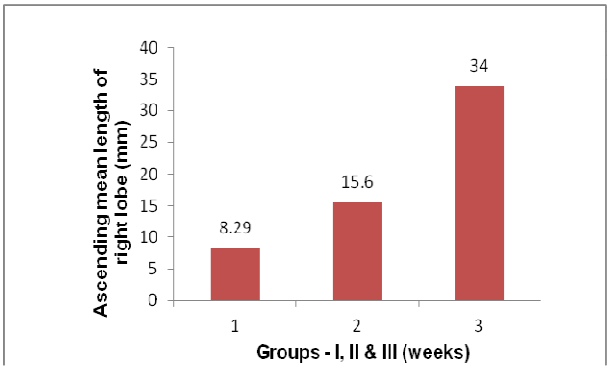

Fig. 5: Bar diagram showing comparison of mean length of right lobe of thymus among three groups

The length of left lobe of thymus gland ranged from 2 mm to 45 mm. Comparison of mean length of left lobe among three groups was evaluated i.e. group I has 6.61±3.82, group II 15.2±3.91, group III 36.55±7.58 (Fig. 6). It was obvious that length of left lobe grew more than right lobe.

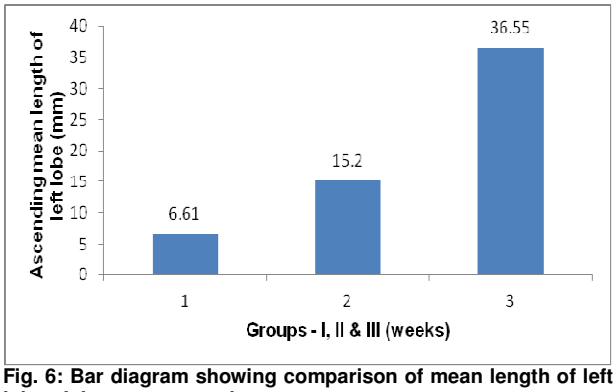

Fig. 6: Bar diagram showing comparison of mean length of left lobe of thymus among three groups

The thymic thickness ranged from 0.5 cm to 1.5 cm. Comparison of mean thickness of all three groups was done i.e. group I has 0.4±0.1, group II 0.5±0.2, group III 0.9±0.4 (Fig. 7). It was obvious that thickness gradually increased from 0.2cm to 1.5cm from 12 to 40 weeks of gestation.

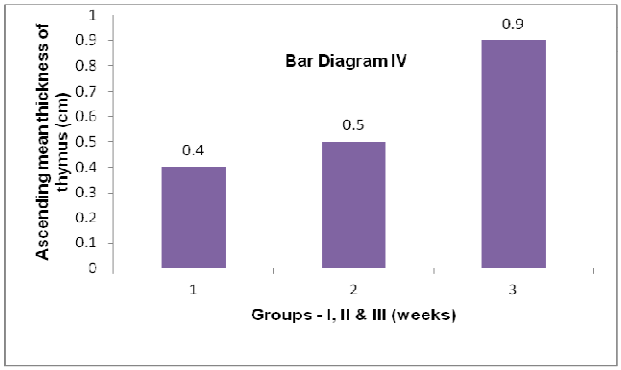

Fig. 7: Bar diagram showing comparison of mean thickness of thymus among three groups

DISCUSSION

Previous authors observed that after 5 months, rate of development of thymus begins to decrease. They also observed that female fetuses appear developmentally older than male fetuses by analyzing most of the morphological features except thymus and adrenal gland which have continuous growth [14,15]. In present study, the position of thymus gland was in superior mediastinum in which 3 of them were extending above suprasternal notch so 3 fetuses had cervical extension of thymus.

Some studies depicted cervical extension of thymus gland in preterm and post term fetuses, and found the cervical extension, from level above thyroid cartilage till suprasternal notch. They found extension of thymus till diaphragm [16,17]. No such observation was found in present study.

The mean length of right lobe of thymus was very much in accordance with the findings of Mamta et al. (2018). According to them, it was 0.98± 0.47 cm in group I, 1.63 ± 0.33 cm in group II and 3.94± 1.05 cm in group III [17]. In present study, mean length of right lobe was 8.39±4.31 mm in group I, 15.6±1.90 mm in group II and 34±10.99 mm in group III.

Yekeler et al. (2004) measured the maximum cranio-caudal length 31.2±4.4 cm in fetus of 31-40 weeks [18]. Nearly similar value was found in present study in group III which was 39.4±10.5 cm. This shows progressive growth of fetal thymus from group I to groups II which becomes more rapid from group II to group III.

Weight of thymus as noted by Mamta et al. (2018) was 0.594±0.336 in group I, 1.99±0.88) in group II and 8.56±3.01 in group III. In present study, the weight of thymus (gm) in group I was 0.47±0.40, 1.79±0.49 in group II and 7.41±3.61 in group III which shows two times growth in weight of thymus in groups I to group II whereas eight times growth from group II to group III. Therefore, growth in group III fetuses was highly significant.

Waszak and Cieslik (2003) studied the weight of thymus in 20-42 weeks of 3389 fetus. They found the weight of thymus about 9.38 gm in male fetuses and 8.16 gm in female fetuses [15]. In present study, thymus was observed at 12th week of gestation weighing about 0.1 gm.

The length of the right lobe showed 2mm and left lobe 1mm thereby confirming the dissimilarity in the lobulation of the thymus as observed by Scott et al. (2002) [19]. There is increase in all morphometric parameters with increase in gestational age of fetus.

CONCLUSION

Thymic morphometric parameters in relation to gestational age can be used as reference values in imaging studies in the prenatal stage and in initial perinatal stage.

The morphometric measurements of thymus is useful in calculating size, as IUGR and cellular

immune deficiency of infant is associated with a significant decrease in fetal thymic size. A basic knowledge about thymic embryology and morphology is also important for diagnosis of ectopic thymic mass and pathological conditions like thymic epithelial tumors.

HIV infection which causes severe loss of T-lymphocytes for which it has become important to understand the role of human fetal thymus as to reactivate cellular immunity.

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Original Article

VARIATIONS IN DORSALIS PEDIS ARTERY

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ABSTRACT

Introduction: Dorsalis pedis artery is the chief artery of the dorsum of foot and is the artery of choice for grafting in vascular surgery of ischemic lower limbs in diabetic patients.

Material & Methods: Dorsalis pedis artery was dissected and traced during routine cadaveric dissection in 41 foots.

Observation & Results: We observed origin of dorsalis pedis artery from peroneal artery in 2.44% cases. Five branches from dorsalis pedis artery were observed in 2.44% and 6 branches in 2.44% cases.

Conclusion: Study of variation in origin and branching pattern of dorsalis pedis artery is helpful in delimiting the graft.

Keywords: Dorsalis pedis artery, dissection, variations, origin, branches.

INTRODUCTION

The arterial pattern of the human body is one of the systems that show a large number of variations. A variation in the course and branching pattern of an artery is both interesting and significant for both clinicians and anatomists [1]. The chief artery of the dorsum of the foot is the dorsalis pedis artery [2]. The term “Dorsalis pedis artery” is obtained from the Latin. The word dorsalis means on the dorsal side. The word pedis means the foot. So, this is the artery which supplies the dorsal side of the foot [3]. The other names of this artery are arteria dorsalis pedis and dorsal artery of foot [4].

In the effort of salvaging the ischemic limb in case of diabetic neuropathy, dorsalis pedis artery bypass plays a major role [5]. The branches of dorsalis pedis artery are used in distal bypass [6]. In revascularization of the foot, dorsalis pedis artery is used as an outflow vessel [7]. It is the most preferred recipient vessel for bypass graft. Variations in course and branches pose a dangerous situation during vascular surgeries. Only few studies are available on the branching pattern of the dorsalis pedis artery and more so in Karnataka. So present study has been done in forty one foot during routine dissection in the department of Anatomy, Dr. B. R. Ambedkar Medical College, K.G. Halli, Bengaluru.

MATERIAL AND METHODS

The dorsalis pedis artery was dissected and traced from its origin up to first metatarsal space, the number of branches and the branching pattern of dorsalis pedis artery was noted.

OBSERVATIONS AND RESULTS

In 40 cases, dorsalis pedis artery was arising from

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anterior tibial artery which is normal, while in one case (2.44%) it was arising from peroneal artery. Five branches from dorsalis pedis artery was observed in 2.44% and 6 branches in 2.44% cases (Table 1). In 7.39% cases, dorsalis pedis artery has a short course and divided into medial and lateral branches named as dorsalis arteria medialis and dorsalis arteria lateralis respectively. The medial branch continued as the first dorsal metatarsal artery and joined the plantar arch. The lateral branch gave off the second, third and fourth metatarsal arteries. Absence of the arcuate artery was also seen in 2.44% of cases. Tetrafurcation of anterior tibial artery (i.e. lateral malleolar artery, medial malleolar artery, lateral tarsal artery and dorsalis pedis artery arises at the same point over the ankle joint) was present in 2.44% of cases. Lateral malleolar artery was a branch of dorsalis pedis artery in 2.44% of cases. (Fig. 1).

Table 1: Origin and branching pattern of dorsalis pedis artery

Origin of dorsalis pedis artery	Numbers of cases	Percentage
From anterior tibial artery (normal)	40	97.56%
From peroneal artery	1	2.44%
Branches of dorsalis pedis artery		
4 branches (normal pattern)	39	95.12%
6 branches	1	2.44%
5 branches	1	2.44%

Fig. 1: Variations in origin and branching pattern of dorsalis pedis artery. (DPA: Dorsalis pedis artery, FDMA: First dorsal metatarsal artery, LMA: Lateral malleolar artery, LTA: Lateral tarsal artery, MMA: Medial malleolar artery, MTA: Medial tarsal artery, PA: Peroneal artery)

DISCUSSION

In present study, origin of dorsalis pedis artery from peroneal artery was present in 2.44% of cases while Vijyalakshmi et al. (2011) have noted in 8% of cases [2]. Vaishnani et al. (2012) and Surekha et al. (2013) also reported origin of dorsalis pedis artery from peroneal artery [8,9]. We noted that in 7.39% cases, dorsalis pedis artery has a short course and divided into medial and lateral branches named as dorsalis arteria medialis and dorsalis arteria lateralis respectively. The medial branch continued as the first dorsal metatarsal artery and joined the plantar arch. The lateral branch gave off the second, third and fourth metatarsal arteries cases while Vijyalakshmi et al. (2011) noted this pattern in 16 % cases [2].

Mitra et al. (2007) reported a case of bilateral absence of the arcuate artery in a 60 years old male [10] while we have noted absence of the arcuate artery in 2.44% of cases. Vijyalakshmi et al. (2011) and Rajeshwari et al. (2013) also noted absence of the arcuate artery in 6% and 16.67% cases respectively [2,11]. In the present study, tetrafurcation of anterior tibial artery (i.e. lateral malleolar artery, medial malleolar artery, lateral tarsal artery and dorsalis pedis artery arises at the same point over the ankle joint) was present in 2.44% of cases. Also in our study, lateral malleolar artery was a branch of dorsalis pedis artery in 2.44% of cases. These above two branching pattern of the dorsalis pedis artery has not been described in the literature.

CONCLUSION

Pulsation of dorsalis pedis artery regarding its location has been reported to vary. The skin of the dorsum of foot has been used for both proximal and distal skin grafting since the dorsalis pedis artery gives off number of cutaneous branches which maintains the nutrition of the graft. Hence the study of variation in origin and branching pattern of dorsalis pedis artery is helpful in delimiting the graft. The individual branches of the dorsalis pedis artery may be used for injecting chemotherapeutic agent for malignancies which are in the initial stages. Dorsalis pedis artery is very useful for vascular surgery in case of ischemia of lower limb.

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Original Article

A COMPREHENSIVE STUDY OF STERNAL FORAMEN IN DRY STERNUM

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ABSTRACT

Introduction: Congenital defects during the development of sternum give rise to sternal foramen. These defects are due to incomplete fusion of sternebrae. Serious life-threatening complications can occur during sternal puncture for bone marrow biopsy. Therefore, knowledge of the presence of sternal foramen is important to prevent these life-threatening complications. Our aim was to observe the incidence, location, number and shape of the sternal foramen in dry sterna.

Material & Methods: The present study was conducted in Department of Anatomy, Subharti Medical College, Meerut in 100 dry sterna. Various types of sternal variations were observed and documented.

Results: In our study, 10% of the sterna had a sternal foramen. Single sternal foramen was present in 8 specimens (8%). Double foramina were present in 2 bones (2%).

Conclusion: Sternal foramen are not uncommon. Knowledge of these variations are important for radiologists and surgeons during bone marrow biopsy.

Keywords: Sternum, foramen, site, shape.

INTRODUCTION

The human sternum consists of cranial manubrium (prosternum), an intermediate body (mesosternum) and a caudal xiphoid process (metasternum) [1]. The sternum is formed by fusion of two cartilaginous sternal plates flanking the median plane. Arrangement and number of ossification centres vary in relation to completeness and the time of fusion of the sternal plates. Incomplete fusion leaves a sternal foramen [1]. Anatomical knowledge of variations of sternum are imperative as their awareness is important for bone marrow aspiration procedure. Defects of the sternum are commonly reported in the lower third as single midline foramen [2]. These sternal foramina are commonly asymptomatic and detected in routine CT scans [3]. The comprehensive study of the sternal foramen is important in acupuncture practices and sternal marrow aspiration to prevent the damage to vital structures like heart and pericardium. The aim of the present study was to find the incidence, site, shape and number of sternal foramen, if present.

MATERIAL AND METHODS

The present study was carried out on 100 dry sterna in the department of Anatomy, Subharti Medical College, Meerut. The morphometry of sternum and sternal variations were observed and documented.

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OBSERVATIONS AND RESULTS

In our study, the sternal foramen was present in 10 sterna out of 100 specimens (10%). In the remaining bones, sternal foramen was absent (90%). In eight sterna (8%), the foramen was single and in two sterna (2%), the foramen was double (Fig. 1 & 2).

Out of 10 sterna having sternal foramen, the foramen was present over the manubrium in 2 bones (2%), over the body in 4 bones (4%), over the xiphoid process in 3 bones (3%) and at the xiphisternal articulation in one bone (1%). Double foramen was present in two sterna over manubrium (Fig. 1-3).

Fig. 1. Single sternal foramen over the body

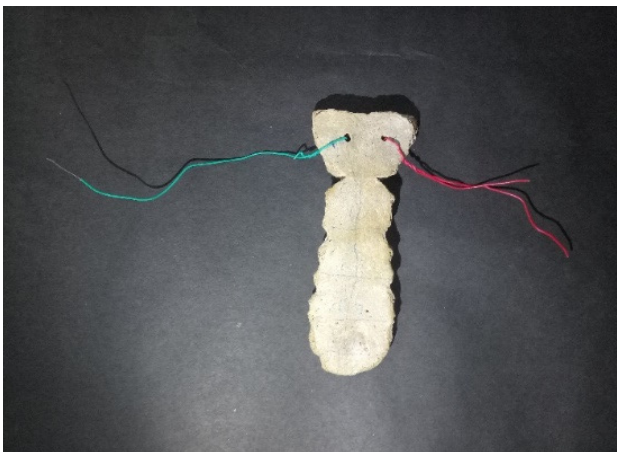

Fig. 2. Double sternal foramen over manubrium

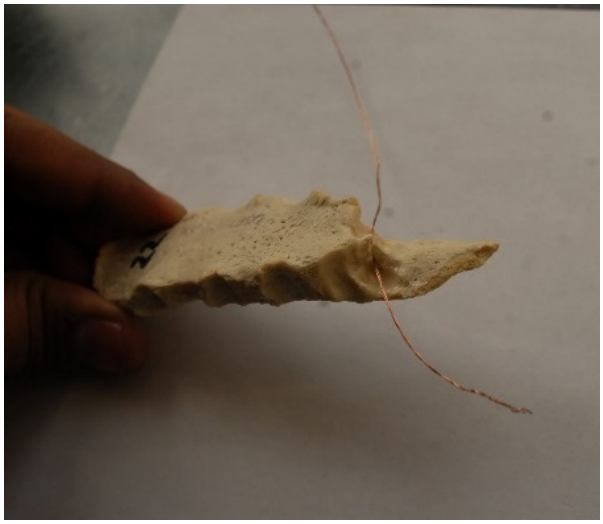

Fig. 3. Single sternal foramen over xiphisternal articulation

Shape of the foramen over manubrium and body was round (6%) while those over the xiphoid process and xiphisternal articulation were oval (4%).

DISCUSSION

Incidence of sternal foramina

In our study, the percentage of the presence of sternal foramen was 10%. It was more than that reported by Cooper et al. (6.7%) [4] while less than that documented by other studies [5-8] (Table 1).

Site of sternal foramina

Site of sternal foramen was reported to be maximum in the body of sternum [5,6,9]. In our study, the incidence of sternal foramen over the body of sternum was 4% which was maximum than noted at other sites (Table 1) and this finding runs parallel with the above mentioned studies. The presence of sternal foramen over the manubrium was 2% in our study which is similar to that reported by Arumugam & Hemalatha (2018) [8]. In 3% cases, the sternal foramen was present on xiphoid which is different from that noted by some previous studies [8,10].

Table 1: Site and incidence of sternal foramen in various studies

Authors	Year	Manubrium	Body of sternum	Xiphoid	Sterno-xiphoid	Incidence of sternal foramen
Cooper et al. [4]	1988	Not specified	1 specimen	-	-	6.7%
Jakhar et al. [11]	2015	-	1 specimen over lower third	-	-	1 specimen
Kumarasamy & Agarwal [12]	2011	-	1 specimen	-	-	1 specimen
Busaid et al. [6]	2011	-	81.8%	-	-	13.8%
Tandon & Gara [13]	2016	-	1 specimen	-	-	
Gkantsinikoudis et al. [9]	2017	-	40%	40%	-	14.2% (male), 6.6% (female)
Babinski et al. [5]	2015	-	38.5 (5th segment), 64.2 (4^{th}-5^{th} segment)	-	-	16.6%
Arumugam & Hemalatha [8]	2018	2%	6%	6%	-	14%
Present study	2019	2%	4%	3%	1%	10%

Number and shape of sternal foramina

Balta (2018) [14] in radiological study documented the incidence of double sternal foramina in body of sternum. Arumugam & Hemalatha (2018) [8] also stated double sternal foramina over the manubrium in one bone and in other specimens, double sternal foramina in xiphoid process. In our study, two double sternal foramina were present and both were present over the manubrium. Cooper et al. (1988) [4] reported double sternal foramina located in body of sternum and over manubrium also. Vora et al. (2014) [15] and Yekeler et al. (2006) [16] reported one single sternal foramen. In our study, both single and double sternal foramen were present. Selthofer et al. (2006) [10] reported oval type of sternal foramen. In or study, both oval and round type of sternal foramen were present.

CONCLUSION

Life-threatening complications like cardiac tamponade and pneumothorax should be kept in mind before performing bone marrow biopsy, acupuncture etc. due to the presence of sternal foramen. So, it is advisable to take x-ray to rule out such variations of the sternum.

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