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<i>Editorial</i>	113
Santoshkumar Dope	
<i>Original Articles</i>	
<b>Effect of Body Mass Index on Bone Mineral Density in Obese Person</b>	115
Anupama Chauhan, R. Fulzele., S. Rawlani	
<b>Digit Ratio and the Age of Occurrence of Myocardial Infarction</b>	121
Mutalik Ashwini Mohan Rao, Hanji Chandrashekhkar Veerabhadrapa	
<b>Study of Digit Ratio and its Relation with Cognitive Ability in Children</b>	125
Mutalik Ashwini Mohan Rao, Begum Naseema	
<b>Study on the Variation of Branching Pattern of Arch of Aorta in Cadavers of North Maharashtra</b>	129
Santosh V. Shinde, Prashant Bhusari, Dinesh Kathe, Kushal Shukla, Karan Khairnar, Manisha Rajale	
<b>A Cadaveric Study of Renal Artery in North Indian Population: Its Clinical Implications</b>	135
Ambica Wadhwa, Sandeep Soni, Avjot K. Miglani	
<b>Incidence of Complete Ossification of the Superior Transverse Scapular Ligament of Human Dry Scapulae in Maharashtrian Population</b>	139
Kirti Chaudhary, Mahesh Shinde, Ashwini Jadhav	
<b>A Novel and Innovative Teaching Tool Using Low-Cost Luminal Cast Plastination of the Trachea-Bronchial Tree</b>	143
Fatima M. DeSouza, Prashant E. Natekar, Nandini M. Karapurkar	
<b>Variation in the Relation of Recurrent Laryngeal Nerve to the Inferior Thyroid Artery: A Cadaveric Study</b>	147
Megha Saknure, Charulata Satpute, Chandrashekhkar Waghmare	
<b>A Study of Growth Pattern in Males and Females at Various Age Groups from Satara District of Maharashtra State</b>	153
Sumedh G. Sonavane, Rupali R. Yadav, Dadasaheb D. Pawar	
<b>A Morphometric Study of the Glenoid Cavity of the Scapula</b>	165
Azhar Ahmed Siddiqui, Zuberi Hussain Riyaz	
<b>Morphological Study of Caecum with Its Arterial Supply in Adult Cadavers and Dead Fetuses</b>	171
Surya Kumari N., Usha C., Srinivas C.H.	
<b>Morphometric Analysis of Dry Adult Human Mandibular Ramus</b>	179
Deepa G., Shrikrishna B.H.	

<b>A Study of Morphology of Psoas Minor Muscle in Human Cadavers</b>	<b>185</b>
Shilpa Bhimalli, Daksha Dixit, S.P. Desai, Amit Magdum, Sheetal Pattanshetti	
<i>Review Article</i>	
<b>Cadaveric Oath and Its Relevance for Students of Anatomy</b>	<b>189</b>
Sharadkumar P. Sawant, Shaheen Rizvi	
<i>Case Report</i>	
<b>Variation of the Left Gastric and Right Inferior Phrenic Arteries: Its Clinical Implication</b>	<b>195</b>
Surekha Dilip Jadhav, Balbhim Ramchandra Zambare	
<i>Short Communication</i>	
<b>Nerve Blood Flow in Diabetic Peripheral Neuropathy: Revisiting the 'Vasa Nervorum' Hypothesis</b>	<b>199</b>
Senthil P. Kumar	
<b>Guidelines for Authors</b>	<b>201</b>

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**Dr. Santoshkumar Dope**  
Editor-in-chief

It is the man's quest for the unknown that brings the best in him. We call it "research" in medical parlance. Medical Science has evolved in the past century in leaps and bounds, all but by small steps. "journey of a thousand miles begins with a single step" said the famous Chinese philosopher Lao- Tze. Indian Journal of Anatomy is one such small step in that direction. "It is not because things are difficult that we do not dare; it is because we do not dare that they are difficult". It needs a personal sacrifice to dwell into those unexplored dimensions of life, the passion and enthusiasm, a single minded purpose which may be rewarded with bounty. Nevertheless the future humanity may reap the harvest. It is those people who sacrificed their personal life and the mundane to emerge victorious in scientific breakthroughs. We, as the present generation are enjoying those benefits. Our communication system has advanced rapidly, the quality of life has increased manifold because of new advances in medicine. Those who are contributing to this journal as an author

or as a reader are doing exactly that. We are making every effort in this direction to make it known through the print media.

Indian Journal of Anatomy is aimed to provide a medium for exchange of thoughts and current researches between anatomists and clinicians.

In addition this journal keeps informing educators about new researches in basic anatomy as well as newer teaching techniques. Indian Journal of Anatomy is dedicated to foster those researches applying anatomic principles to the solution of clinical problems. On the other side researchers can also use clinical observations to expand horizons of anatomical knowledge. We hope our readers will continue to find this volume as a valuable resource & it will fire their enthusiasm for a fascinating field of study.

We are grateful to all the authors who have submitted their valued work for publication. At last but not the least we are also thankful to Red Flower Publication for their continuous help and support.

We promise that the team of Indian Journal of Anatomy will strive hard to achieve the highest possible quality to enhance a clear, concise and precise understanding of anatomy to all.

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## Effect of Body Mass Index on Bone Mineral Density in Obese Person

Anupama Chauhan\*, R. Fulzele.\*\*, S. Rawlani\*\*\*

### Abstract

The present study was done in the dept. of Anatomy with collaboration of dept. of Orthopedics. The aim of study was to compare the effect of body mass index on bone mineral density in obese persons.

- Obesity is a condition of excessive body fat that causes several public health problems. Body mass index is calculated by height and weight.

Body Mass Index =  $\text{Weight in Kg} / \text{Height in M}^2$

- Obesity and osteoporosis are two common complex diseases with multifactorial etiology. Strong positive association between body mass index and bone mineral density is well defined in postmenopausal women but not in men. (Tooth et al 2005)

- The present study was conducted on 200 subjects of age above 20 years. The weight and height of each subject was measured with the help of weighing machine and body mass index was calculated by above formula. Bone mineral density was obtained with ultra sonographic bone densitometer. The distal end of radius and mid shaft of tibia were the sites used for measuring B.M. D.

The present study concluded that there is no correlation between body mass index and bone mineral density and it is statistically significant.

**Keywords:** Body Mass Index; Bone Mineral Density.

### Introduction

Obesity and osteoporosis are two common complex diseases. Both having multifactorial etiologies, including genetic, environmental components with potential interaction between them.

Body mass index is widely used as an index of degree of obesity, primarily as it is easy to measure. Body mass index is calculated by height and weight, height in meters and weight in kilograms [1].

BMI =  $\text{weight in kilograms} / \text{height in meter}^2$ .

Obesity is defined as body mass index >24 and is categorized as mild, moderate and severe as follows.

Body mass index	>25 - mild,
	>30 - moderate,
	>35 - severe

Extensive epidemiological data shows that high body weight or BMI is correlated with high bone mass and reduction in weight may cause reduction in bone mass [2].

Toth E. et al. reported that there is association between body mass index and bone mineral density and this is observed in postmenopausal women but not in men [2].

Bone density is highly correlated with bone strength and fracture risk. A 1 standard deviation decrease in BMD is associated with 1.5 to 3 times increase in risk of future fracture depending on site of measurement.

---

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Bone mineral density is measured by various techniques. The choice of technique to use in measuring bone density is based on availability, cost, accuracy, precision diagnostic sensitivity and experience with various methods [3].

The World Health Organization standards for characterizing patients as normal (with 1sd of peak bone mass), osteopenia (1 to 2.5sd below peak bone mass) and osteoporotic (>2.5sd below peak bone mass) are based on central DXA measurements [3].

Detailed quantitative knowledge about bone mineral density in obese people is necessary for prediction of fracture risk. Hence this study was undertaken to investigate if there is any association or effect of body mass index on bone mineral density

in obese patients [4].

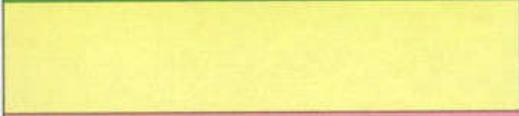
### Material and Methods

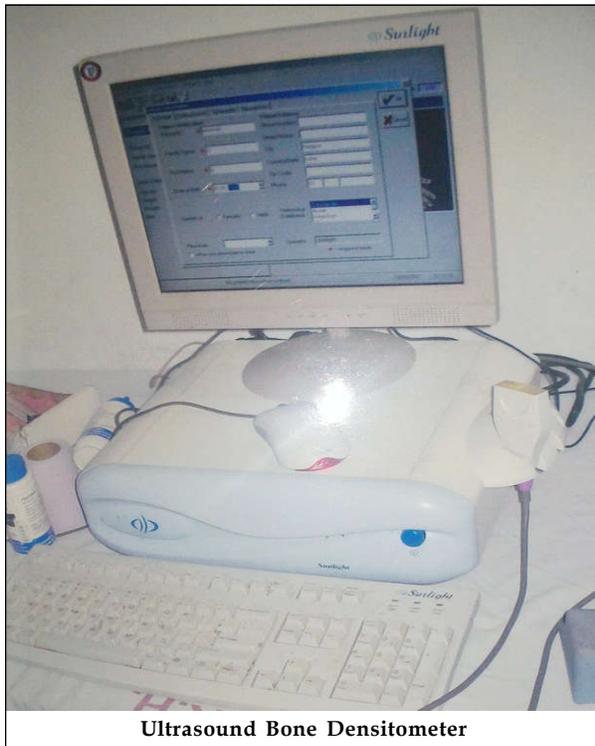
The study was designed to include normal weight and over weight subjects of both sexes, 100 each, total 200. The weight and height of each subject was measured with the help of weighing machine and measuring device.

Body Mass Index was obtained from formula.

$$\text{BMI} = \frac{\text{weight in kg}}{\text{height in m}^2}$$

Bone Mineral Density of each subject was obtained from ultrasonographic Bone Densitometer

<b>Bone Mineral Density Report</b>		
Name : _____	ID _____	
Scan Date _____	Age: _____ Sex : _____	
Consulting Doctor : _____		
<b>RBD(Reference Database) Asian</b>		
Normal		<b>Normal</b> -1
Osteopenia		<b>Medium Risk</b>
Osteoporosis		-2.5 <b>High Risk</b>
20 30 40 50 60 70 80 (AGE)		
<b>SCAN INFORMATION</b>		
TECHNIQUE : ULTRASONOGRAPHY		
Sites: Distal Radius/ Midshaft Tibia		
Findings : <input type="checkbox"/> Normal <input type="checkbox"/> Osteopenia <input type="checkbox"/> Osteoporosis		
T Score : _____	Z Score _____	
<b>COMMENTS :</b> _____		
Courtesy : Zuventus Healthcare Ltd.      Authorised Signatory _____ Office No. 519, 5 <sup>th</sup> Floor, D-Wing, Oberoi Garden Estates, Chandivali, Andheri(E), Mumbai 400072.		



Ultrasound Bone Densitometer

The distal radius or midshaft of Tibia were the sites for measuring Bone Mineral Density.

### Observations

On screening wide range of literature regarding fracture risk it was found that measurement at any site with any of the different types of densitometry equipment provide information about fracture risk. Low bone densities of single site is still an indicator of increased risk of fracture even though other sites are normal [5].

The T-score compares patients bone density to that person who is 30 years old. This age was chosen since it is the time when you attain your peak bone mass. The scores are reported as standard deviation above or below peak bone mass .one standard deviation below is approximately equal to 10 to 15 percent decrease in bone density. The t score is given positive and negative number where a negative number represent the bone loss [6].

### T- score interpretation

Above = -1	Normal Bone Mass
Between= -1 and -2.5	Osteopinea (low Bone Mass)
Below = -2.5	Osteoporosis

**Table 1:** Distribution of subjects as per BMI

Group	Body Mass Index	Male	Female	Total	Percentage
Non obese	Normal (up to 24)	60	55	115	57.50
Obese	Mild (25-30)	25	28	53	26.50
	Moderate(31-35)	10	9	19	9.50
	Severe(>35)	5	8	13	6.50
	Total	100	100	200	100.00
	Z-Test		1.13		
	P-Value		0.006		
	Significance		Significant, p<0.05		

This table shows significant p value on distribution of subjects according body mass index.

**Table 2:** Correlation of BMI & Age

Age Groups	Non Obese Group Normal(upto 24)		Mild (25-30)		Obese Group Moderate (31-35)		Severe (>35)	
	Male	Female	Male	Female	Male	Female	Male	Female
21-30	11	25	6	4	4	0	0	0
31-41	11	12	8	13	1	2	1	2
>40	38	18	15	14	3	4	2	6
Total	60	55	29	31	8	6	3	8
X <sup>2</sup> - test	12.44		1.56		4.27		0.07	
P- Value	0.002		0.45		0.11		0.78	
Significance	Significant P<0.05		NS P>0.05		NS P>0.05		NS P>0.05	

This table shows comparison of subjects according body mass index and age.

**Table 3:** Sexwise distribution of BMD

Sex	Bone Mineral Density					
	Normal		Osteopenia		Osteoporosis	
	Non Obese	Obese	Non Obese	Obese	Non Obese	Obese
Male	20	18	20	14	20	8
Female	15	20	15	15	25	10
Total	35	38	35	29	45	18
Fishers Exact Test	0.48		0.61		1.00	
P-Value	NS, p>0.05		NS, p>0.05		NS, p>0.05	

This table shows sex wise. distribution of bone mineral density, with no significant p value

**Table 4:** Correlation of BMI &BMD

Group	Body Mass Index	Bone Mineral Density					
		Normal		Osteopenia		Osteoporosis	
		Male	Female	Male	Female	Male	Female
Non obese	Normal (up to 24)	20	15	20	15	20	25
Obese	Mild(25-30)	10	14	9	10	5	4
	Moderate(31-35)	4	3	5	2	2	4
	Severe(>35)	4	3	0	3	1	2
	Total	38	35	34	30	28	35
	X <sup>2</sup> -test	16.55, p-value=0.01, Significant, p<0.05					

This table shows correlation of body mass index and bone mineral density, with significant p value

The results are given in numerical form and require physician interpretation. The results are given as to different scores the T-score and Z-score [6].

## Discussion

Detailed quantitative knowledge about the effect of age and bone density on absolute risk of fracture is necessary to evaluate the potential benefit of interventions aimed exclusively at bone density. The association of low bone mass with an increased risk of hip fracture is well documented [7].

In our present study there is no correlation found between body mass index and bone mineral density.

Coin A. et al (2000) [8] reported the underweight state in the elderly is associated with malnutrition and osteoporosis, besides body composition changes, such as protein deficiency could be involved in association between underweight and osteoporosis. In present study these factors were not include.

In the present study 30.43% subjects were having normal BMD, and 30.43% were having osteopenia and 39.13% were having osteoporosis. Whereas 44% subjects of obese group were having normal BMD, 34.11% subjects were having osteopenia and 21.17% subjects were having osteoporosis in correlates these observations to Lan Juan et al (2006) [1] reported that high body mass index may not have any effect on bone mineral density.

According to ICMR bulletin (1-4, april 2005)

women with decreased bone density usually have no complaints or specific abnormal physical findings. Our findings correlate with their findings..

Tooth et al (2005) [9] found strong positive association between body mass index and bone mineral density in post menopausal females but not in males, in our study no such correlation was found in the subjects of either sex belonging to this age group. Felson D.T. (1993) reported the effect of weight and of weight change on bone mineral density was in general much less in males than in females. The strong effect of weight on bone mineral density is due to load on weight bearing bones in both sexes. In our study there is no such correlation of body mass index and bone mineral density of non obese as well as obese males and females.

In present study the maximum number of subjects i.e. 44% of age group 21-30 years where having normal BMD. Maximum no of subjects 97% of age group 40 and above where having osteopenia and osteoporosis. This results of our study correlate with the study of Stephan et al (1997) [10] who reported measurements at distal radius BMD strongly influenced by age.

Edelstein S.L., et al (1993) [11] suggested that bone mineral density was measured at midshaft and distal radius with a single photon absorptiometry in their study, all measures of body size were associated with BMD in both sexes and were better markers of bone mineral density in weight bearing site than in non weight bearing site implying a mechanical effect of weight on bone mineral density.

In present study the bone mineral density was measured at distal radius and tibia by ultrasonographic bone densitometer and there is no difference in bone mineral density of radius and midshaft tibia.

Kofi Asomaning et al (2006) [12] reported that women with low body mass index are at increased risk of osteoporosis. To help reduce the risk of osteoporosis, patient should be advice to maintain normal weight. In present study there was no such correlation of body mass index and bone mineral density was found on the contrary there was reverse correlation of body mass index and bone mineral density and subjects with low body mass index were not included in our study.

### Conclusion

Bone density measurements are done in order to determine if low bone mass, to predict risk of future fracture, to determine which subject may need drug therapy.

As per our observation bone density testing should be recommended to all women and men above age group of 40 years and for younger subjects who have clinical risk factors irrespective of obesity. Bone density measurement being very simple, noninvasive method, can be used for mass screening population at a large scale.

The present study concluded that there is no correlation of body mass index and bone mineral density and it is statistically significant.

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## Digit Ratio and the Age of Occurrence of Myocardial Infarction

Mutalik Ashwini Mohan Rao\*, Hanji Chandrashekhar Veerabhadrapa\*

### Abstract

Digit ratio shows sexual dimorphism and is influenced by oestrogen and testosterone while in womb. This digit ratio can be used as biomarker to know about the age of occurrence of MI. We conducted digit ratio study on 25 men and 25 women both in case and control. In the normal healthy men the average 2D:4D ratio was 0.94 and in women it was 0.95. While in cases we found that 2D:4D ratio in men with MI was 0.98 and that in women it was 0.97. The average age of occurrence of MI was 58 in men and 53 in women. Hence, we are of opinion that digit ratio can be used as a non-invasive and inexpensive biometric screening procedure for early detection of MI.

**Keywords:** Digit Ratio; Age; Myocardial Infarction.

### Introduction

Many studies have been done which support the connection between 2D:4D ratio and prenatal exposure to testosterone and oestrogen. Further this ratio shows relation with aggression, dominance, sporting and musical ability, fertility and health status. People who are at risk of MI early in their adult lives can be identified simply by measuring their fingers and can change diet and exercise to reduce the risk. Finger ratio is biological and medical dream which is easily and non-invasively measured as a screening tool for MI.

Digit ratio is the ratio of length of index and ring fingers typically measured from the bottom crease where fingers join the hand, to the tip of the fingers which is said to be affected by the exposure to androgens while in the uterus. The relation between testosterone and heart disease is surprising and counter intuitive, because it protects against heart attacks in men. Thus fingers may therefore provide a window into the important process of sexual differentiation in the womb.

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### Method

Using the digital Vernier's Caliper, we measured the length of index finger and ring finger of right hand in 25 male and 25 female MI patients aging 30 years onwards which was compared with 25 male and 25 female controls. The right hand was chosen for stronger relation with 2D:4D ratio. The cases were collected from S.Nijalingappa Medical College and HSK Hospital, Bagalkot.

To measure the digit ratio, the proximal most crease near to the palm of the index and ring finger were selected and a mid-point of the crease was taken till the tip of the respective fingers using digital Vernier's Calipers. Then the length of the index finger was divided by ring finger to get the digit ratio. If the 2D / 4D value is less than 1, it implies that the ring finger is longer than the index finger. This type is called Casanova pattern which is usually seen in males. If the value is equal to 1, then the fingers are equal in length and are usually seen in females. If the 2D / 4D ratio is greater than 1, it implies that the index finger is longer than the ring finger. This is known as Meng's pattern[1].

In the present study, we have compared the digit ratio and its relation to the age of occurrence of MI on 50 cases and 50 controls.

### Results

In our present study, we took 25 men and 25

women as control group and 25 men and 25 women in case study. We took into consideration of the entire person above the age of 30 years. We excluded deformed hands. Medical ethical clearance was taken along with consent of cases and controls.

In the normal healthy men the average 2D:4D ratio was 0.94 and in women it was 0.95. This agrees with the sexual dimorphism and lower 2D: 4D ratio in men when compared to women.

While in cases we found that 2D:4D ratio in men with MI was 0.98 and that in women it was 0.97. The average age of occurrence of MI in men was 58 and in women it was 53.

As proved by Manning, men with shorter ring finger tend to be at greater risk than the men with longer ring finger. This necessarily does not mean that all men with shorter ring finger should have MI, but they can be alerted. They can then be advised to eat low fat, reduced salt intake, avoid smoking, regular exercise etc.

When it comes to women, they are little lucky, to be protected by the oestrogen. Hence early MI are very uncommon during premenopausal age.

## Discussion

Myocardial Infarction has been one of the biggest killer of this generation. Considering the vast amount of money that goes into developing and marketing products for screening and diagnosis of MI, it is provocative to think that our own external features may afford us a technology and money free way of finding it out. The relative length of index and ring fingers may contain information related to our health. According to Manning, when the foetus is in the womb it has a profound programming effect on its biology. Foetal physiology and biochemistry are very difficult to measure directly. There are many ethical and methodological problems associated with determining hormone concentrations in human foetal blood. Difficulties in measuring the foetus often lead us to measure children and adults instead. For example the important problem of coronary heart diseases a major chronic disease affecting adults. It has been found that some human populations have a higher incidence of heart disease than others, and that these populations also have high incidences of smoking, obesity, high cholesterol and high blood pressure. To combat this in 1960s and 1970s many people took to dieting, jogging and aerobic exercise with a consequent reduction in the heart attack rates. However, by the mid-1980s it was apparent that many

lean and hungry non-smokers were still dying of premature heart attacks. Infact lifestyle factors account for only about 25% of adult death from coronary heart diseases. Evidence is mounting that biological programming at the foetal stage is an important factor in the reminder.

Further work has shown that high cholesterol and elevated levels of clotting factors may also be associated with reduced foetal growth. This then is the biological programming model of heart disease. It suggests that many of the characteristic and function of our cardiovascular system are determined before birth. However, the essence of this model is that prenatal influences, often during the early stages of foetal growth may trigger major diseases in adult life. To an evolutionary biologist with an interest in sex differences the most striking pattern associated with coronary heart disease is the excess of male victims. Heart attacks are uncommon among pre-menopausal women, and so mortality rates from coronary heart diseases are 2 to 3 times higher in men compared to women. Many diseases show sex differences in their expression and progression. These sex differences are indicators of prenatal effects of sex hormones such as testosterone and estrogen. The finger ratio also shows evidence of sex differences and is prenatal in origin [2].

There is also evidence that Hox genes are responsible for digit development. Direct effects of sex hormones on bone growth might be responsible either by regulation of Hox genes in digit development or independently of such genes [3].

An examination of 56 human embryos and foetuses at various stages of development has shown that the relative lengths of fingers are established remarkably early in development. By the seventh week of intra uterine life the foetus has established near adult proportions of fingers relative to each other and to the length of the bones making up the hand. There is then a relative elongation of the bones at the ends of the fingers followed by a return to adult proportions. The result is that by the thirteenth week of pregnancy adult proportions are reached in the hand [4]. During this period, if the foetus is exposed to androgens the exact level of which is thought to be sexually dimorphic, the growth rate of fourth digit is increased. This is analysed by 2D/4D ratio of opposite sex dizygotic twins where the female twin is exposed to excess androgens from her brother in utero and thus has a significantly lower 2D/4D ratio [5].

There is evidence that testosterone enhances the efficiency of Cardio Vascular System in men. Oestrogen on the other hand is seen as a protective against heart disease because premenopausal

women rarely have heart attacks. Men who have had heart attacks tend to have lower levels of Testosterone than healthy men who are of similar age and body weight. Testosterone may enlarge the blood vessels resulting in less resistance to blood flow and may also protect against thickening of arteries. In contrast, high oestrogen levels may be related to the increased heart attacks in young men [6,7].

It is found in the latest studies that female type finger ratio in men are related to high levels of fibrinogen. This is large molecule which is present in large amounts than required for maintaining the integrity of vascular system. The result is that the heart of men with high fibrinogen levels must labour to pump their viscous blood around their body. While men with Casanova type ratio have low fibrinogen and low viscosity blood which slips easily through narrow capillaries[8]. High blood viscosity may result in continually high resistance to the action of the heart, which could wear it down. This long process of attrition may then accelerate the age related process of vascular decline. Again lifestyle factor would be relevant. For example weight gain; increases in stress, smoking and ageing have all been linked to increase in Fibrinogen concentration. We cannot only consider Fibrinogen as the only variable in the decline of our heart and blood vessels. High cholesterol in our blood stream especially LDL is an established indicator of risk for serious heart disease.

It is proved that high levels of TSH stimulate thyroid gland to produce T4 which increases metabolic and heart rates. If metabolic control is set so that TSH is consistently produced in high amounts, this would lead to an elevated heart rate, arrhythmias and even heart attacks. A study done in China on 140 children, it was found that children with high TSH levels and having female type finger ratio are more prone for Heart attacks [9].

According to Manning, men with a Casanova type finger ratio tend to have their first MI late in life while those with female type finger ratio tend to experience it early[10].

In a study done on Greek men and women found 2D:4D ratio significantly higher in men with MI than the respective ratio in healthy men. But no significant differences were observed in the ratios between women with MI and healthy women. Sexual dimorphism of digit ratios was present in both groups [11].

In a study done on Chinese population showed an association between High 2D:4D ratio and Coronary artery disease in both hands in men. There were no significant differences in mean 2D:4D between women with coronary artery disease and controls [12].

## Conclusion

In our study, we found that the average age of occurrence of MI was 58 in men and 53 in women. Finger ratio can function as a very early warning sign of poorly formed vascular system. Further, sex hormones also play a major role in the occurrence of MI. Thus, the digit ratio can be used as a non-invasive and non-expensive biometric screening procedure for the early detection of MI. However we also feel many more studies are required to test the sound knowledge of 2D:4D ratio and its relation with MI.

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## Study of Digit Ratio and its Relation with Cognitive Ability in Children

Mutalik Ashwini Mohan Rao\*, Begum Naseema\*\*

### Abstract

Digit ratio is the ratio of the length of second and fourth digits typically measured from the bottom crease where fingers join the hand, to the tip of the fingers. This ratio is said to be affected by the exposure to the androgens while in womb. In our study digit ratio is used to predict the cognitive ability of the children. Usually 2D: 4D ratio is lower in males than in females implying greater exposure to androgens. In the present study, we found the average 2D: 4D ratio of girls to be 0.94 and boys 0.95 respectively. Hence we are of the opinion that this is just a crude indicator of the cognitive ability in children. Therefore, further research is needed to gain insight in this aspect.

**Keywords:** Digit Ratio; Androgens; Cognitive Ability.

### Introduction

People are eager to learn palmistry since fate reading is an amazing study that entices everyone across the globe. Then came the study of Dermatoglyphics, a scientific study of finger prints, lines, mounts and shapes of hands. The latest of all these is the study of fingers length, which is known as digit ratio.

It is known through several studies that the ways in which men & women differ in their behavior and health like verbal, mathematical, musical and other abilities like strength, running, swimming speed, prevalence of heart disease and the probability of heart attacks, predisposition to cancers, depression etc., all show different intensities of development, manifestations and rates of progression in one sex compared to the other. This may sound bizarre but our fingers, more precisely ring & index finger can throw some light on this issue. These fingers provide us with evidence of how men & women differ and how they are programmed before birth to show certain sex related behavior patterns and disease

predispositions.

In the present study we have measured the length of ring finger and index finger to calculate the digit ratio and then we correlated the digit ratio with the children's performance in Mathematics and Language.

### Methods

Using the digital Vernier's Caliper, we measured the length of index finger and ring finger of right hand in the school children aging between 11 to 15 years. Their digit ratio was calculated i.e 2D / 4D. We also made record of the marks obtained by each pupil in mathematics and language in their annual exams. In our study the number of pupils were 68, out of which 32 were girls and 36 were boys. We excluded the deformed hands. We also took the consent of students, parents and teachers.

To measure the digit ratio, the proximal most crease near to the palm of the index and ring finger were selected and a mid-point of the crease was taken till the tip of the respective fingers using digital Vernier calipers. Then the length of the index finger was divided by ring finger to get the digit ratio. If the 2D / 4D value is less than 1, it implies that the ring finger is longer than the index finger. This type is called Casanova pattern which is usually seen in males. If the value is equal to 1, then the fingers are equal in length and are usually seen in females. If the 2D/4D

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ratio is greater than 1, it implies that the index finger is longer than the ring finger. This is known as Meng's pattern [1].

**Results**

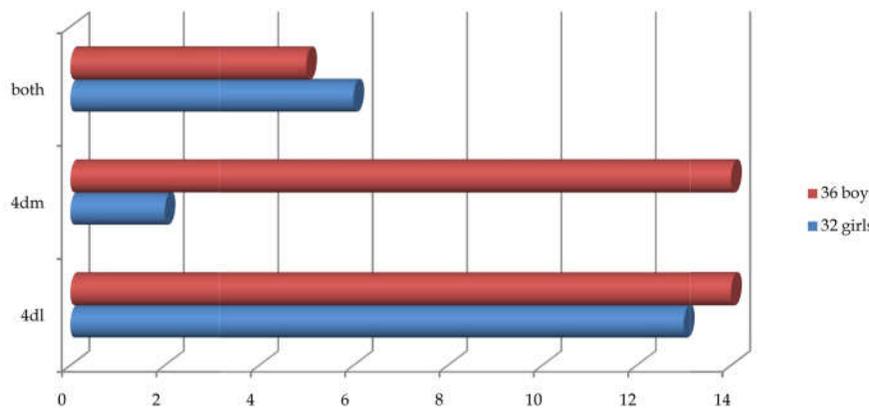
In our present study among 32 girls, 13 girls had increased 4D length and excelled in language. Only 2 girls with increased 4 D length did well in mathematics. Further 6 girls scored same marks in language and mathematics. We noted that, of the above 6 girls, 4 girls had increased 4D length. There were around 12 girls whose 2D/4D ratio was equal to 1. Of these, 7 did well in language. The average of

2D/4D ratio was 0.94. There were 22 girls whose 2D/4D ratio was above 0.94.

In the 36 boys, 14 had increased 4D length and excelled in mathematics. In the language also, there were 14 boys with increased 4D length. Further 5 boys scored same marks in language and mathematics. There were 4 boys whose 2D/4D ratio was equal to 1 and of these 3 excelled in language. The average 2D/4D ratio was 0.95. We had 13 such boys whose 2D/4D ratio was above 0.95.

Outcome of the study was that, of the 68 children 45 had increased 4D length and they excelled in their academics either in numeracy or literacy and not exactly in mathematics with increased 4D and in literacy with increased 2D.

Increased 4D length in language, mathematics and both

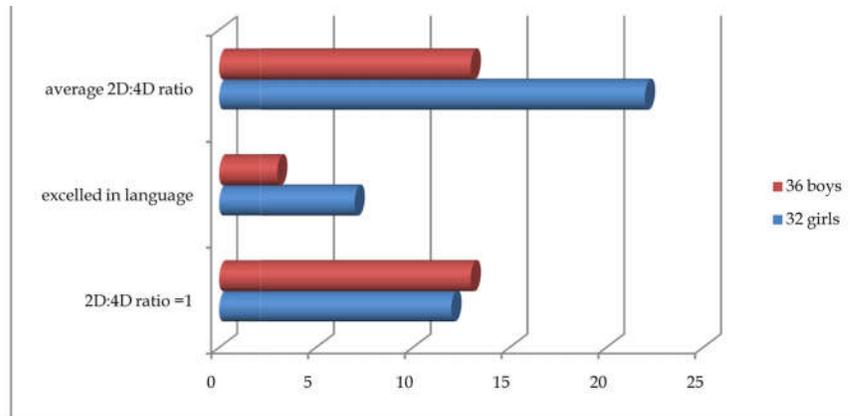


➔ Number of students

4Dl= 4D length in language, 4Dm= 4D length in mathematics, both= 4Dl and 4Dm

**Chart 1:** Illustrating increased 4D length in language, mathematics and both in girls and boys

2D:4D=1, excelled in language and average 2D:4D ratio



➔ Number of Students

**Chart 2:** Illustrating 2D:4D=1, excelled in language and average 2D:4D ratio in girls and boys

## Discussion

The digit ratio is the ratio of the length of index and ring fingers, measured from the midpoint of the bottom crease to the tip of the fingers. This ratio is said to be affected by the exposure to the androgens in the intrauterine life. This 2D/4D ratio can be considered as a crude measure for prenatal androgen exposure [2,3]. The formation of digits in humans in the intrauterine life is thought to occur by 13 weeks and the bone to bone ratio is consistent from this point in to an individual's adulthood [4]. During this period, if the fetus is exposed to androgens the exact level of which is thought to be sexually dimorphic, the growth rate of fourth digit is increased. This is analyzed by 2D/4D ratio of opposite sex dizygotic twins where the female twin is exposed to excess androgens from her brother in utero and thus has a significantly lower 2D/4D ratio [5].

Compared to females, males tend to be less neurotic and less intuitive when guessing the emotional state of others. Males tend to display large muscle movements and physical aggression, but are also prone to hyperactivity, short attention span and language problems such as dyslexia, poor verbal fluency and stammering. However high ability in spatial judgment, problem solving, competitive sports, some aspects of mathematics, writing and performing music are more likely to be found in males than in females [6].

There is evidence that testosterone in the womb reduces language ability but favours the development of abilities in music, drawing and perception of shapes. High prenatal testosterone may also be important in influencing carrier choices like mathematics, physics and engineering [7].

In a study done by Noam Chomsky and his colleagues, the ability to learn language appears early in children developments. They learn the vocabulary and rules of sentence construction for their particular language with ease and usually without formal instruction. Thus the brain is programmed so that children simply infer the rules of sentence construction appropriate for their particular language. In order to explain this and other features of language acquisition they argued that there is within the brain a deep structure which is universal to all languages and is a fundamental aspect of the brain of modern humans [8].

However, linguistic ability is not uniform across all humans. There is sexual dimension, many aspects of language showing female superiority. In a Verley's Verbal test conducted to recall words associated with

groups such as musicians, animals, politicians & sports people, it was found that this semantically based fluency shows the female advantage. Hence those who have on average been exposed to high prenatal estrogen, tend to excel word fluency [9].

In another study done on 100 women and 100 men it was found that high semantically based fluency was indeed related to female type finger ratios and it seems that high prenatal estrogen is associated with aspects of language in the individual and to the evolution of language in the human species [10].

A study done in UK on 75 school children of age 7 concluded that numeracy rate was good for males indicating higher prenatal testosterone exposure in intrauterine life and females excelled in literacy indicating lower prenatal testosterone exposure in intrauterine life [11].

British international school did a study on 136 men and 137 women were of the opinion that if a low 2D/4D ratio is indeed due to testosterone exposure in the womb (which is not confirmed), then that raises the question as to why testosterone exposure should affect mathematical ability. And if it is not connected between digit ratio and mathematical talent? Does the relationship still hold for when we look at algebraic skills rather than numeracy or is algebraic talent distinct from numeracy talent? [12].

In a study done by Stefen on 100 young males and females explores association between 2D/4D ratio on the one hand and age, life history and BMI on the other hand. They found a decrease in 2D/4D ratio from typically feminine to typical masculine in the right hand of women. In men, they found negative association between 2D/4D ratio and BMI [13].

Many studies are of the opinion that the levels of sex hormones fluctuate during growth and development. Various sexually dimorphic traits differentiate at different ages which obscure associates between 2D/4D ratio and traits affected by sex hormones [14].

Trivers found a variation of 60% in 2D/4D ratio of the right hand, in children between seven and thirteen years four years later [15]. Hence MC Intyre says that sex differences in fingers of children are highly correlated with adult finger length ratios and the digit ratios have the potential to change during development and do not uniquely reflect fetal exposure to sex hormones [16].

From all the above studies we feel that 50% studies are agreeing with the 2D/4D ratio and its relation with exposure to androgens in intrauterine life, while other 50% studies don't hold good with the 2D/4D ratio and the concept of androgen exposure.

## Conclusion

In our study, we found the girls and boys 2D/4D ratio to be 0.94 and 0.95 respectively. These findings question the validity of 2D/4D ratio as a predictor of human sexual behavior which in turn is related to prenatal exposure to androgens. Hence our study which is done on small sample size may show some contrast and may not support the 2D/4D ratio totally. More research is needed to gain insight which can correlate the different components of human behaviors with the 2D/4D ratio.

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## Study on the Variation of Branching Pattern of Arch of Aorta in Cadavers of North Maharashtra

Santosh V. Shinde\*, Prashant Bhusari\*\*, Dinesh Kathe\*, Kushal Shukla\*\*\*, Karan Khairnar\*\*\*, Manisha Rajale\*\*\*

### Abstract

*Aims and Objectives:* The variations of vessels arising from the aortic arch are numerous. The purpose of this study is the description of the variations on the branching pattern of arch of aorta, in order to offer useful data to anatomists, radiologists, vascular surgeons, neck and thorax surgeons in North Maharashtra subjects, and relating it with embryological basis. *Materials and Methods:* Sixty Six arches of adult North Maharashtra cadavers were exposed and their branches examined during cadaveric dissection in the Department of Anatomy of MVPS Dr. Vasanttrao Pawar Medical College, Nashik and PDDVPFs Medical College Ahemadnager, Maharashtra. *Result:* In this investigations three-branched aortic arch was found in 59 cadavers (89.39 %); the 5(7.57 %), remaining aortic arch showed only two branches, out of which one was a common trunk, which incorporated the brachiocephalic trunk and left common carotid and other left subclavian artery and 2(3.03 %) aortic arches showed direct arch origin of the left vertebral artery. *Conclusion:* The accurate information on this is vital for vascular surgery in the thorax, head and neck regions. Although, the variations are usually asymptomatic, they may cause dyspnea, dysphagia, intermittent claudication, misinterpretation of radiological examinations and complications during neck and thorax surgery. These observations are precious while invading the arch of aorta and its branches by instruments, as all areas are susceptible to surgical attack.

**Keywords:** Thoracic Aorta; Variations; Branches; Vascular Surgery.

### Introduction

The arch of the aorta is a continuation of the ascending aorta, located in the superior mediastinum. Three branches – the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery – usually arise from the arch of aorta. The brachiocephalic trunk later divides into the right common carotid and the right subclavian artery (Standring, 2005) [1].

Most of the anomalies of the arch of the aorta and its branches are as a result of an altered development of primitive aortic arches of the embryo during the early gestation period (Nurru et al., 2009) [2].

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An understanding of the variability of these arteries remains most important in angiography and surgical procedures where an incomplete knowledge of anatomy can lead to serious implications.

This has become more important in the era of carotid artery stents, vertebral artery stents, and therapeutic options for intracranial interventions (Poonam et al., 2010) [3].

### Materials & Methods

Sixty Six arches of adult North Maharashtra cadavers were exposed and their branches examined during cadaveric dissection in the Department of Anatomy of MVPS Dr. Vasanttrao Pawar Medical College, Nashik and PDDVPFs Medical College Ahemadnager, Maharashtra.

The dissection of the thoracic region was carried out according to the instructions by Cunningham's Manual of Practical Anatomy (Vol. 2). The dissections took place during the years 2013-2015.

The arteries were allowed to dry and then photographed. Photographs of the variant anatomy of the aortic arch were taken using a digital camera. The variant patterns were tabulated (Table 1).

No additional anomalies or pathological changes were found on the remainder of vessels and other organs of the thoracic cavity of the same cadaver.

## Results

In this investigations three-branched aortic arch was found in 59 cadavers (89.39 %); the 2(3.03 %) remaining aortic arch showed only two branches, out of which one was a common trunk, which incorporated the brachiocephalic trunk and left common carotid and other left subclavian artery and 5(7.57 %) aortic arches showed direct arch origin of the left vertebral artery.

The arterial pattern was congregated into three categories based on the frequencies of variations (Vicurevic et al., 2012) [4] (Table 1).

1. *Type I* - 59 cases (89.39%): Normal pattern (Figure 1)
2. *Type II* - 05 cases (07.57%): An aberrant origin of the left vertebral artery (LVA), which showed a typical vessel arrangement (BCT, LCCA, LSA) with the LVA origin between the LCCA and LSA. The left vertebral artery was also arising from the arch of the aorta in addition to the other normal branches (Figure 2).
3. *Type III* - 02 case (3.03%): Only two branches were seen to arise from the arch of the aorta i.e., a common brachiocephalic trunk (CBT), branching into brachiocephalic trunk and left common carotid artery. The LCCA and BCT shared the same site of origin and the LSA was originated from the aortic arch as the most distal branch (Figure 3).

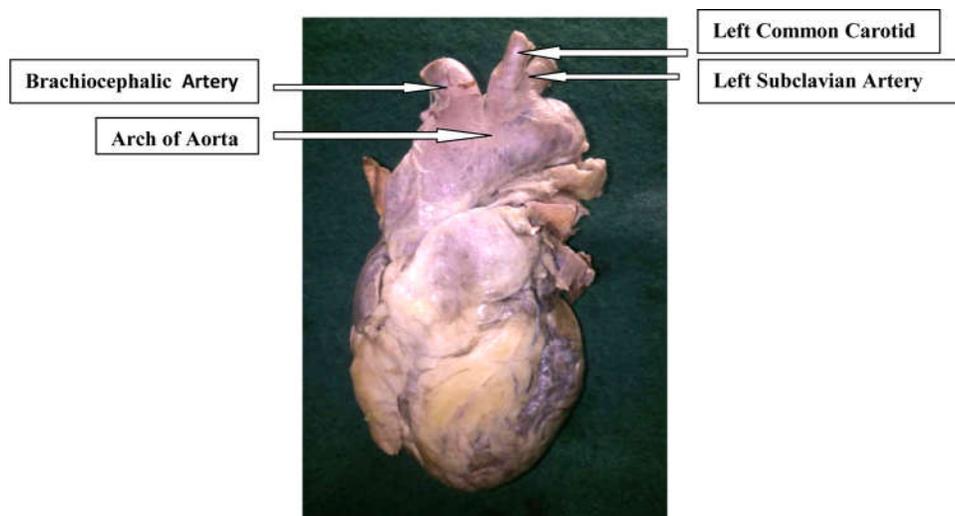


Fig. 1: Arch of aorta shows three branches

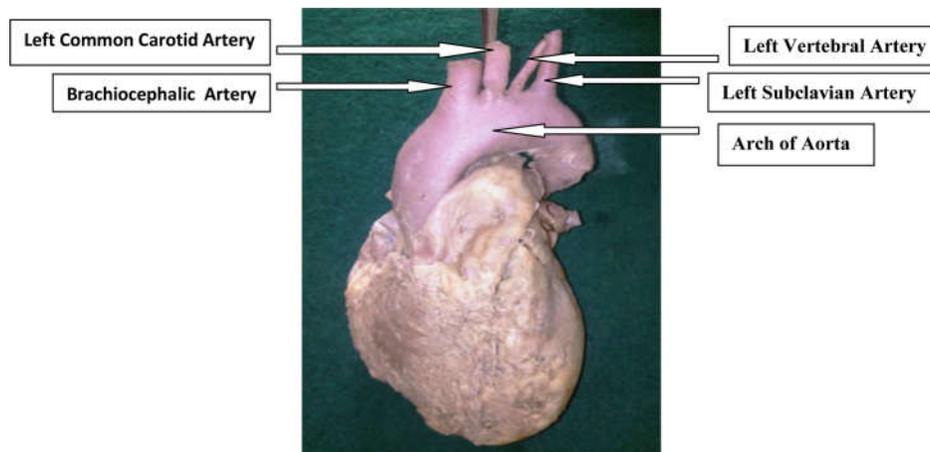


Fig. 2: Arch of aorta shows four branches

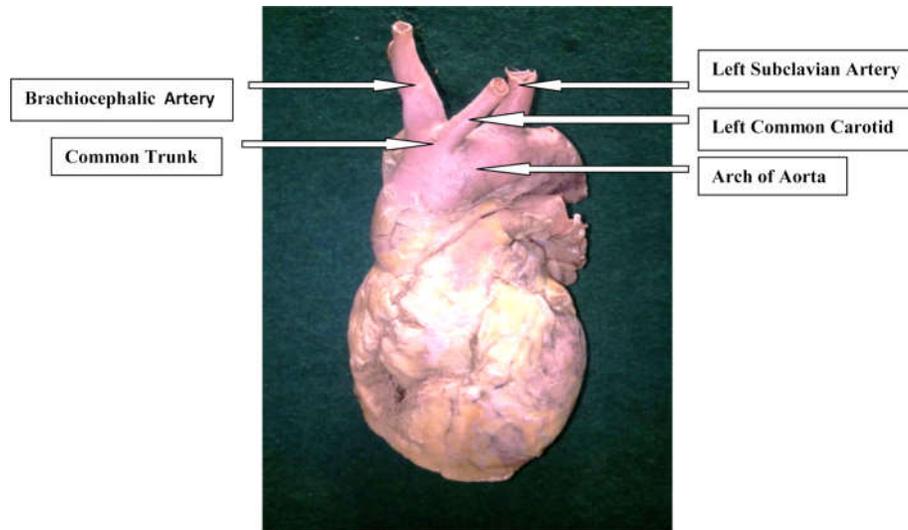


Fig. 3: Arch of aorta shows two branches

Table 1: Types of variations in the arch of aorta

Type	Number of Branches	Description of Branches	Frequency	Percentage (%)
I	3	BCT, LCCA, LSA.	59	89.39 %
II	4	BCT, LCCA, LVA, LSA.	5	7.57 %
II	5	CT (BCT, LCCA), LSA.	2	3.03 %
	Total		66	100 %

BCT (Brachiocephalic Trunk); CBT (Common Brachiocephalic Trunk); LCCA (Left Common Carotid Artery); LSA (Left Subclavian Artery); LVA (Left Vertebral Artery).

Table 2: Incidence of the types of variations in the branching pattern of the arch of aorta

Type	Adachi et al. (1928) (%)	Mc Donald and Anson (1940) (%)	Mc Donald and Anson ((1940) (%)	Mc Donald and Anson ((1940) (%)	Nayak et al. (2006) (%)	Ajit Kumarand Amarnath Mishra (2015) %	Present study (%)
I	83.3	66.9	51.7	8.3	91.4	83.33	89.39 %
II	4.3	1.46	---	0.79	1.6	11.90	7.57 %
II	10.9	25.5	41.4	15	4.8	2.38	3.03 %
IV	0.8		1.7	0.16	1.6	2.38	---
	516 Japane	157 American White	59 American Black	633 Greek	62 Indians	42 Nepalese	66 North Maharashtrans (indians)

**Discussion**

Variations of the great arteries in the thoracic region are well known and the aortic arch is one of them. Aortic arch anomalies may also be attributed to chromosomal abnormalities. Momma et al. (1999)<sup>[5]</sup> noted that aortic arch anomalies are associated with chromosome 22q11 deletion.

The variations of the branches of the arch of the aorta are usually associated with abnormalities of the heart and persistent foetal conditions. Many variations are due to differences in the mode of transformation of aortic arch vessels from the branchial arches, especially from the fourth arch.

Since the aorta and pulmonary artery develops from a common conus arteriosus, irregular and imperfect development of the septum between them may also produce variations (Bergman et al., 1996) [6].

In the present study 59 cases (89.39%) showed a normal branching pattern i.e., the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery and the variations were found in 10.60% of the cases.

These variations are likely to occur as a result of differential development of certain branchial arch arteries during the embryonic period of gestation (Natsis et al., 2009) [7].

The type I arterial arrangement represents the normal branching pattern of the arch of the aorta, reported in 89.39% of the cases. This is in close agreement with the studies have done by various authors (Table 2).

The current study reveals 05 cases (7.57 %) of Type-II pattern i.e., the left vertebral artery arising from the arch of aorta in addition to the other normal branches.

This suggests that part of the arch of the aorta may be arising from the 7th intersegmental artery or may be due to increased absorption of embryonic tissue of the left subclavian artery between the arch of the aorta and the vertebral artery (Moore et al., 2003) [8].

According to Bernardi and Detori, the unusual origin of the vertebral artery may favor cerebral disorders because of alterations in the cerebral hemodynamics (Bernardi et al., 1975) [9].

Such anomalies can cause ischemia, as well as infarction of the brain stem and cerebellum if the vertebro-basilar axis is left dominant and communication at the arterial circle of Willis is poor (Yamashiro et al., 2010)[10].

In this study we observed 02 case (3.03 %) of Type-III pattern i.e., two branches arising from the arch of the aorta, a common brachiocephalic trunk branching into brachiocephalic trunk and left common carotid artery. The left subclavian artery was however arising separately from the arch of the aorta (Figure 3).

The uncommon branching patterns of the aortic arch are due to either persistence of certain aortic arches which should be obliterated normally or viceversa.

The proximal part of the third aortic arch normally gets extended and absorbed into the left horn of the aortic sac. If it gets absorbed into the right horn of the aortic sac, it can lead to anomalies where the left common carotid artery arises from the brachiocephalic trunk or the left horn of the aortic sac is fails to develop (Goray et al., 2005 [11]; Nayak et al., 2006) [12].

There so the left 3rd aortic arch derivatives (LCCA) is directly connected with the right 3rd aortic arch (BCT) or right horn of aortic sac.

Similar reports were documented by Natsis et al. (2009) [7], Paraskevas et al. (2008) [13], Gupta and Sodhi (2005) [14], and Satyapal et al. (2003) [15].

Accidental occlusion of this common trunk may have major ischemic complications given that it supplies both carotids, right vertebral and subclavian arteries.

## Conclusion

The wide range of anatomical variations in the

branching pattern of aortic arch in North Maharashtra subjects was observed to have three types of variations but the percentage was minimal compared to other regions of populations thereby these variations serve as a valuable tool for a safe endovascular surgeries and angiographies.

Clinicians and surgeons should be aware of aortic arch variations. Prior identification of these vascular anomalies through diagnostic interventions is crucial in order to avoid complications during heart and vascular surgeries.

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## A Cadaveric Study of Renal Artery in North Indian Population: Its Clinical Implications

Ambica Wadhwa\*, Sandeep Soni\*\*, Avjot K. Miglani\*\*\*

### Abstract

A thorough knowledge of the variations of the renal artery has grown importance with the increasing numbers of renal transplants, vascular reconstructions and various surgical and radiological techniques. The present study was conducted on 30 well embalmed human cadavers during routine dissection to note the normal anatomy and variations of renal artery. Accessory renal arteries in the present study were found in 10 cases (33.3%) and were more frequent on left side i.e. in 7 cases (70%) than on the right side 3 cases (30%). To plan the adequate surgical procedure and to avoid any vascular complication, Multi Detector Computer Tomography (MDCT), angiography and arteriography should be performed prior to surgery (nephrectomy). As the number of renal surgical and radiological interventions increase, a better understanding of the anatomy of renal arteries and their branches gain importance.

**Keywords:** Renal Artery; Nephrectomy; Angiography; Arteriography.

### Introduction

More than that of any other organ in the body, the vascularization of the kidney (viscus elegantissimum of the ancient anatomists) has been the topic of repeated anatomic investigation, statistical analysis and description [1].

The renal arteries arise one on each side, about 1.5 cm below the origin of the superior mesenteric artery opposite the second lumbar vertebra [2]. Of the pair, the right artery tends to arise at a higher level than the left, though they lie at the same level in 35% of individuals. The diameter of the renal artery averages 5.8 mm (3 mm to 9 mm) [3]. The average length of right renal artery is 7.7 cm and of the left is 6.2 cm [4].

Renal artery variations are often seen and generally categorises into presence of accessory or aberrant renal arteries, polar arteries, and prehilal branches. Prehilal multiple branching pattern was described

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as duplicate, triplicate, fork pattern and ladder pattern by Shoja et al.,[5] and Rao et al.,[6].

Knowledge of the variations of renal vascular anatomy has importance in exploration and treatment of renal trauma, renal transplantation, renal artery embolization, surgery for abdominal aortic aneurysm and conservative or radical renal surgery [7].

An aberrant inferior polar artery of aortic organ arching around the renal vein acts as pathological agent in production of hydronephrosis by compressing the ureter. An aberrant renal artery may simultaneously produce hydronephrosis and varicocele by compressing testicular veins and ureter [8].

We believe that awareness of variations is necessary for surgical management during renal transplantation, repair of abdominal aortic aneurysm, urological procedures and for angiographic interventions.

### Material and Methods

The material for this study comprised of 30 well embalmed adult human cadavers of known sex obtained from the Department of Anatomy, Govt. Medical College, Amritsar. They were serialized from 1-30 with suffix 'M' for male and 'F' for female. The

abdominal cavity was opened by a cruciform incision passing through the whole thickness of the anterior abdominal wall. Flaps were reflected. The abdominal viscera i.e. stomach, intestines liver, pancreas and spleen were systematically removed according to Cunningham's Manual of Practical Anatomy [9].

The Following Parameters Were Noted

1. Vertebral level of origin
2. Diameter of the artery
3. Any variation

## Results and Discussion

The renal arteries vary on the two sides and in different individuals, in terms of calibre, level of origin

and precise topographic relationships [10].

Impairment of the renal arterial supply caused either by disease process or by surgical manipulation, may result in the production of pressure substances by the involved kidney and subsequent development of systemic hypertension. Therefore in plastic procedures involving the renal pelvis or ureter or even in procedures involving simple ligation and severance of an accessory renal artery, familiarity with the variations in the vascular supply is mandatory [11].

### Vertebral Level of Origin

In the current study in maximum number of cases (36 i.e. 60%) the renal arteries originated at the level of lower border of L<sub>1</sub> vertebra.

**Table 1:** Incidence (sidewise) of vertebral level of origin of renal artery

Vertebral level	No. of cases of renal artery		Total	%age
	Right	Left		
Lower border of L <sub>1</sub>	20	16	36	60.0
IV disc between L <sub>1</sub> & L <sub>2</sub>	6	10	16	26.6
Upper 1/3 <sup>rd</sup> of L <sub>2</sub>	3	3	6	10.0
Middle 1/3 <sup>rd</sup> of L <sub>2</sub>	1	1	2	3.3
<b>Total</b>	<b>30</b>	<b>30</b>	<b>60</b>	

Anson [3] stated that the level of origin of renal arteries is principally centered over the lower third of first lumbar vertebra (L<sub>1</sub>), at the disc between the 1<sup>st</sup> and 2<sup>nd</sup> lumbar vertebrae or at the cranial third of L<sub>2</sub> vertebra and variations extending to one vertebra above and below may occur.

### Diameter at Origin

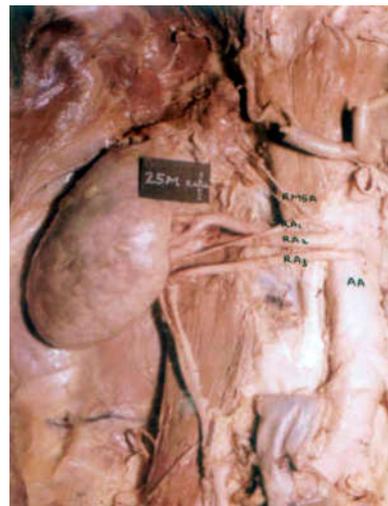
In the present study, the mean diameter of renal artery on the right side was 8.5 mm (range 4mm - 13 mm) and on left side was 8.2 mm (range 6mm - 13 mm). These findings were in near consonance with Keen [12] who reported the mean diameter of renal artery to be 7.9 mm with a range of 6.5 mm- 9.2 mm.

### Accessory Renal Artery

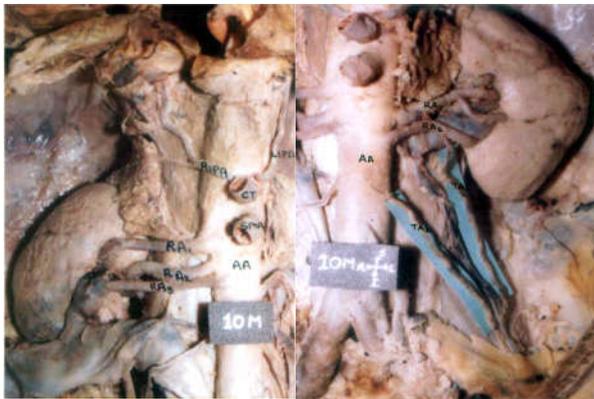
Variations of renal arteries occur more frequently, perhaps, than anomalies of any of other larger vessels; most common anomaly being the presence of accessory renal arteries [13]. The abnormalities in the renal arteries are mainly due to various developmental positions of the kidney [14].

Accessory renal arteries in the present study were found in 10 cases (33.3%) and were more frequent on left side i.e. in 7 cases (70%) than on the right side 3 cases (30%). Out of these 10 cases a single accessory

renal artery were seen in 9 cases (90%) but in two case (10%) (10 M, 25 M) triple hilar arteries derived from aorta were seen; an observation reported to be infrequent (1-2%) by Merklin and Michels [1]. Rusu reported bilateral double renal arteries on the right side as superior hilar and inferior hilar arteries and on the left side as superior hilar and inferior polar renal arteries. All these renal arteries emerged from the abdominal aorta as in our case [15].



**Fig. 1:** Triple renal artery (RA1, RA2, RA3) on right side with superior renal artery (RA1) taking origin in common with right middle suprarenal artery (RMSA)



**Fig. 2:** Triple renal arteries on right side and double renal arteries on left side



**Fig. 3:** Double renal arteries (RA1, RA2) seen on the left side with a distance of 4.2 cm between the origin of two arteries from abdominal aorta (AA)

According to Bayramoglu et al., the variations in the number of renal arterial divisions in the hilar region are generally associated with renal malformations in the embryo [16].

According to Novice et al., there is no definite limit to the number of accessory renal arteries; although more than three on the same side seems to be very rare [17]. Rossi et al., [18] reported a case with seven renal arteries while Kinnunen et al., reported another case with ten additional renal arteries [19].

The anatomical knowledge of multiple arteries is essential before performing any transplantation surgeries, where microvascular techniques are employed to reconstruct the renal arteries [20]. The embryological explanation of these variations has been presented and discussed by Keibel F and Mall FP [21]. In an 18mm foetus, the developing mesonephros, metanephros, suprarenal glands and gonads are supplied by nine pairs of lateral

mesonephric arteries arising from the dorsal aorta. Felix divided these arteries into three groups as follows: the 1<sup>st</sup> and 2<sup>nd</sup> arteries as the cranial group, the 3<sup>rd</sup> to 5<sup>th</sup> arteries as the middle group and 6<sup>th</sup> to 9<sup>th</sup> arteries as the caudal group. The middle group gives rise to renal arteries. Persistence of more than one renal arteries in the middle group results in multiple renal arteries [21].

## Conclusions

The knowledge of renal angioarchitecture, whether usual or variant, is considered to be a prerequisite for successful and uncomplicated surgical and radiological procedures.

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## Incidence of Complete Ossification of the Superior Transverse Scapular Ligament of Human Dry Scapulae in Maharashtrian Population

Kirti Chaudhary\*, Mahesh Shinde\*\*, Ashwini Jadhav\*\*\*

### Abstract

The superior transverse scapular ligament bridges across suprascapular notch to form a suprascapular foramen which transmits the suprascapular nerve. This ligament is sometimes ossified which may lead to suprascapular nerve entrapment syndrome. In the diagnosis of suprascapular nerve entrapment syndrome, variations in the anatomy of the transverse scapular ligament must be considered as possible etiologic factor.

The aim of this study was to see the incidence of the ossified superior transverse scapular ligament on dried human adult scapulae. 90 dried scapulae from the Anatomy Department of Dr. VMGMC, Solapur were examined. Scapulae with damaged superior border were not considered for the study. Scapulae with ossified superior transverse scapular ligament were recorded.

The anatomical knowledge of ossified superior transverse scapular ligament may be helpful for neurosurgeons and clinicians dealing with suprascapular nerve entrapment neuropathy.

**Keywords:** Entrapment Syndrome; Superior Transverse Scapular Ligament; Suprascapular Nerve.

### Introduction

The scapula is one of the bone of the shoulder girdle. It is flat, triangular in shape and is situated in the postero-lateral part of the chest wall overlapping the second to seventh ribs. Superior transverse scapular ligament converts the scapular notch into suprascapular foramen and is attached medially to the limit of the notch and laterally to the root of the coracoid process. The suprascapular nerve passes below the ligament through the opening, while the suprascapular artery and vein passes above the ligament.

Suprascapular nerve is a branch from upper trunk of brachial plexus, supply the motor branches to supraspinatus and infraspinatus muscles and sensory branches to rotator cuff muscles and

ligaments of shoulder girdle. Many researchers reported variable incidence of complete ossification of superior transverse scapular ligament which varies in different population. The documented variations of this ligament include calcification, partial or complete ossification and multiple band. Rarely, the suprascapular nerve becomes entrapped in this region as first described by Thomas in 1936 [1]. Ossification of the suprascapular ligament results in a bony foramen through which the suprascapular nerve passes and may result in suprascapular nerve compression [2,3,4].

In the diagnosis of suprascapular nerve entrapment syndrome, these variations in the anatomy of the superior transverse scapular ligament sometimes feature in the hierarchy of possible etiologic factors. Sporting activities with a predilection for such compression are gymnastics, tennis, weightlifting, boxing, and baseball pitching [2]. We are describing a completely ossified superior transverse scapular ligament in a dried scapulae of an adult Indians. We studied about this topic as in maharashtrian population there is less data about ossified superior transverse scapular ligament of dry scapulae.

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## Materials and Methods

The total of 90 dried human adult scapulae were studied in the Anatomy department of Dr. Vaishampayan memorial Government medical college, Solapur, irrespective of age and sex to see the presence of ossified superior transverse scapular ligament. Each bone was closely observed for the presence of suprascapular foramen and was photographed.



## Result

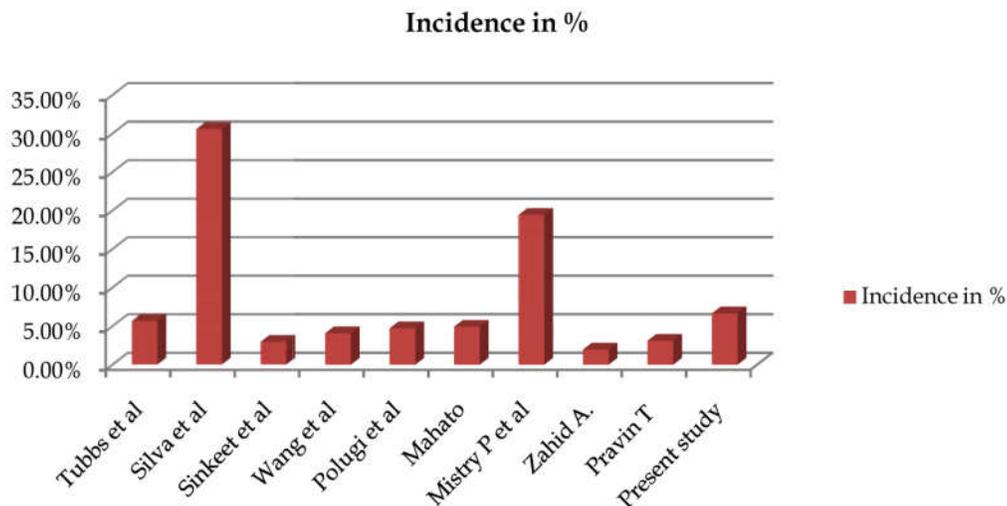
Out of 90 Scapulae, complete ossification of superior transverse scapular ligament was found in six scapulae i.e. 6.66%. Three scapulae were of right side and three scapulae were of left side.

## Discussion

The suprascapular nerve is a motor nerve originating from c5 and c6 nerve roots of upper trunk of the brachial plexus. It passes through the suprascapular notch which is covered by the transverse scapular ligament into the supraspinous fossa where it supplies the supraspinatus muscle. The nerve continues around the lateral border of the spine of the scapula to supply the infraspinatus. Depending upon where the compression occurs either both or individual muscles may be involved.

**Table 1:** Table showing incidence of completely ossified superior transverse scapular ligament in different populations.

S. N	Study	Year	Country	Incidence in %
1.	Tubbs et al	2003	America	5.7%
2.	Silva et al	2007	Brazil	30.6%
3.	Sinkeet et al	2010	Kenya	3%
4.	Wang et al	2011	China	4.08%
5.	Polugi et al	2013	Poland	4.72%
6.	Mahato	2013	India(Andhra Pradesh)	4.92%
7.	Mistry P	2013	India (Surat)	19.44%
8.	Zahid A.	2014	Pakistan	1.96%
9.	Pravin T	2015	India (Madhya Pradesh)	3.1%
10.	Present study	2016	India (Maharashtra)	6.66%



**Graph 1:** Studies of different workers showing incidence of completely ossified transverse scapular ligament in different populations

The suprascapular notch is frequently bridged by bone rather than ligament, converting it into a foramen in some animals. But in humans, the conversion of suprascapular notch into foramen as a result of ossification of superior transverse scapular ligament differs in different populations. Tubbs reported incidence of complete ossification of the ligament as 5.7% in American population [5]. Silva et al studied the prevalence of the ossified superior transverse scapular ligament on dry bones of scapulae in Brazilian population and reported the incidence to be 30.76% [3]. Sinkeet et al observed the incidence of completely ossified ligament in Kenyan as 3% [6] while Wang et al and Polugi et al reported the incidence to be 4.08% [7] and 4.72% [8] respectively. According to Raj Kishore Mahato complete ossification of the ligament is 4.92% and also he describes that ossification may be influenced by age, mechanical load on ligament, sex and genetic factors and can be one of the risk factors for suprascapular entrapment neuropathy [9]. According to Mistry P studies the incidence of ossified ligament is 19.44% in Surat population [10]. In Pakistani population the incidence of complete ossification of the ligament was reported as 1.96% by Zahid A [11] and Pravin T observed the incidence as 3.1% [12]. The present study shows complete ossification of superior transverse scapular ligament in maharashtrian population as 6.66%.

Scapulae with an ossified suprascapular ligament resulting in a foramen scapulae have been classified as type VI by Rengachary et al. [13] and as type III by Ticker et al. [14] For most suprascapular nerve injuries, initial nonsurgical treatment is preferred [15,16]. Patients may present with a history of symptoms provoked by dominant upper extremity movement when suprascapular nerve got compressed. It is hypothesized that repetitive overhead motion or trauma contributes to ossification of the ligament as the incidence of entrapment of the suprascapular ligament is largely increased with strenuous overhead motion (e.g., volleyball, baseball).

Treatment for compression of the suprascapular nerve begins with physical therapy to strengthen the rotator cuff musculature. If conservative treatment fails, surgical decompression of the suprascapular ligament is recommended. This may be performed from an anterior, superior, or posterior direction [17,18]. Generally, a 10- cm incision is made 1 cm proximal and parallel to the spine of the scapula with the trapezius muscle either split or elevated [17]. Arthroscopic decompression may facilitate a more rapid recovery especially when the entrapment is caused solely by the ossified ligament [15]. The subperiosteal technique, according to de Jesus avoids

dissection of the trapezius and supraspinatus muscles and results in less soft tissue damage [18].

## Conclusion

The present study indicates that complete ossification of superior transverse scapular ligament can occur in Maharashtrian population as well and will be of help to the clinicians and surgeons in the diagnosis and treatment of suprascapular nerve entrapment.

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## A Novel and Innovative Teaching Tool Using Low-Cost Luminal Cast Plastination of the Trachea-Bronchial Tree

Fatima M. DeSouza\*, Prashant E. Natekar\*\*, Nandini M. Karapurkar\*\*\*

### Abstract

Plastination of human tissues is one of the techniques that involve preservation by replacing water and liquids with polymers which are subsequently hardened. Luminal cast plastinated specimens are not only suited for our routine anatomical teaching and serve as base images for animation, but also provide excellent source to understand the three dimensional anatomical structure and its variations.

The present study is being done to create an awareness of the simple technique with very low cost in preparation of luminal cast plastinated specimens of trachea-bronchial tree using general purpose silicon sealants in sheep lungs. These specimens contribute to our teaching aids to understand the three dimensional concept of trachea-bronchial tree in lungs and also additional information to our existing knowledge to arrive at a diagnosis of various bronchopulmonary anomalies, before any surgical interventions.

**Keywords:** Plastination; Tracheo-Bronchial Tree; Luminal Cast; Innovative Teaching.

### Introduction

Plastination is derived from the Greek word "Plassein" = to shape, to form. The term in fact, a creation of Gunther von Hagens of University of Heidelberg [1]. Plastination helps us to preserve individual organs from the body after death or to preserve the entire body as well. Cadavers remain a principal teaching tool for anatomists and medical educators teaching gross anatomy. Dissection of cadavers has provided us a strong edifice so that we can express our surgical talents for independent learning and thinking, perform psychomotor skills and exchange our views. Dissection can thus play many roles in the educational process. Unfortunately the specimens used for teaching and learning are unpleasant due to odors and irritation to the eyes, nose and skin causing conjunctivitis, rhinitis and dermatitis. In order to overcome these hazardous effects of formalin fixed specimens, low cost luminal

cast plastination process has an important role in producing specimens which are dry, odorless, life like, maintenance free, durable, natural looking and non-hazardous. In luminal cast plastination, using general purpose silicone sealant, a replica or mold of any tubular structure like tracheo-bronchial tree, arteries, veins, ducts, hollow organs including bony passages or cavities can be studied including anatomical variations. Earlier studies reveals production of tracheobronchial cast by injecting the trachea with ERTV silicone [2]. However resins used in anatomical corrosion specimens were brittle, which often shatter and may be totally destroyed if dropped [3]. Various studies reveal the use of silicon sealants for luminal cast plastination [4-8]. The aims and objectives of the present study is to provide a low cost simple technical procedure of luminal cast plastination so as to keep ourselves abreast with the existing knowledge and also before any surgical interventions, procedures which are therapeutic and diagnostic.

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### Material and Method

The present study was carried out in the department of anatomy at Goa Medical College Bambolim Goa, India. Four freshly cut sheep lungs were obtained from the slaughter house. Each

specimen was carefully examined and cleaned. They were then washed thoroughly in continuous running tap water so as to remove the blood and mucus. The excess water was removed by gently pressing the specimen. This procedure was repeated several times until clear water flowed from the trachea. The specimens were kept inclined, with the trachea at a lower level. So as to ensure complete drainage 280 ml General purpose silicone sealant from ABRD and Araldite brand was injected slowly under pressure into the lumen of trachea of each specimen so as to fill the entire tracheo-bronchial tree. The luminal end of trachea was tied and the specimens were immersed in a bucket of water overnight. The specimens were transferred to a vessel containing boiling water and were kept boiling for nearly one hour and were removed once the lung and tracheal tissue started separating from the cast. They were then allowed to cool and the lung tissue was separated carefully. These plastinated casts were washed in soapy water and displayed.

### Observation and Results

In our present study, four specimens were made by using general purpose silicon sealant. One of the specimens showed only bronchopulmonary segments showing trachea, principle bronchi, secondary bronchi and tertiary bronchi (Figure 1), whereas the others showed the entire tracheobronchial tree (Figure 2)

The sheep lung has two lobes on the right and one lobe on the left. The additional bronchus of the right lung divides into two bronchi (Figure 1). Two principle bronchi (right and left) are seen. Each principle bronchus divides into three secondary bronchi in the right lung and two secondary bronchi in the left lung. These secondary bronchi further divides into tertiary bronchi in both the lungs. The tertiary bronchi of right

and left lungs are as follows:

- 1 Right additional bronchus dividing into two
- 2 Right superior lobar bronchus
- 3 Right middle lobar bronchus
- 4 Right basal anteromedial bronchus
- 5 Right basal lateral bronchus
- 6 Right apical
- 7 Right posterior basal
- 8 Left apical
- 9 Left posterior
- 10 Left anterior
- 11 Superior lingular
- 12 Inferior lingular

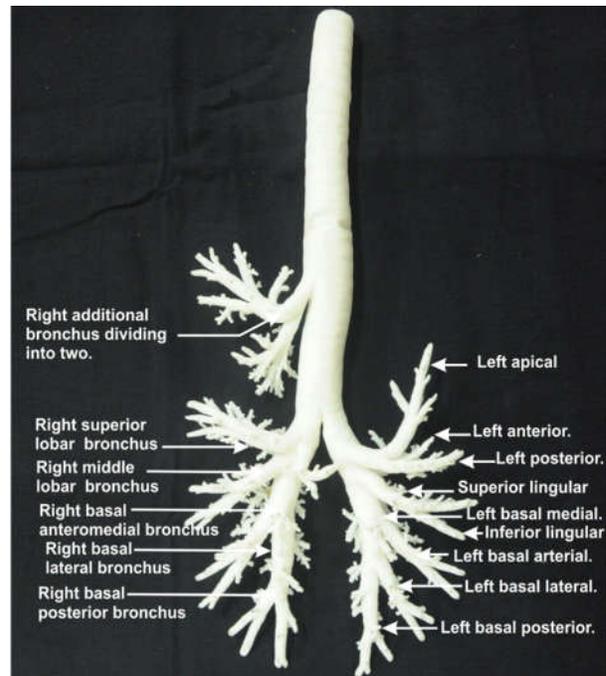


Fig. 1: Bronchopulmonary segments of sheep lung

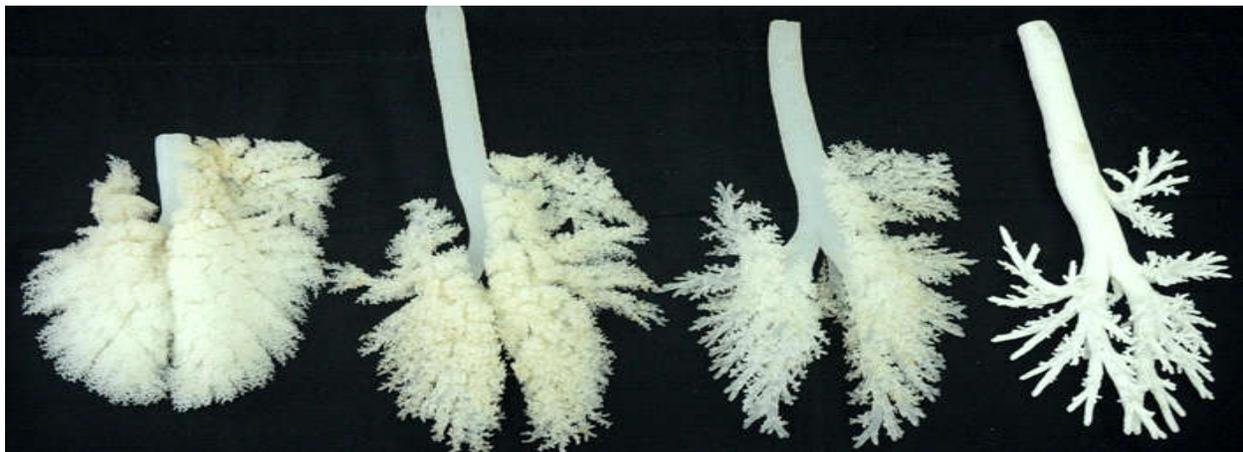


Fig. 2: Showing specimens of tracheobronchial tree of sheep lung

- 13 Left basal apical
- 14 Left basal medial
- 15 Left basal anterior
- 16 Left basal lateral
- 17 Left basal posterior

### Discussion

Clinically significant developmental anomalies of the bronchopulmonary segments are rarely seen during the routine dissections. Several researchers have revealed preparation of corrosion casts Frederick Ruysch (1653-1731), Boyle, Pecquet, Leiberkuhn (1748), Hyrtl (1860), Schiefferdecker (1882), Huntington (1897) [9]. Earlier studies reveal paraffin casts of ureteral calyces [9], vascular casts using vinylite resins [10], vascular casts of liver [11], tracheobronchial tree in horses [12], tracheobronchial casts of cat, dog, horse, pig and ox [13] splenic artery in human [14], Human heart, ventricles of brain [15]. Earlier study found that all the plastinated resources available were heavily used and deemed useful by students and concluded that traditional material should be used in conjunction with plastinated resources [16]. Studies also reveal that similar cast made from vinylite and latex were not durable as silicone cast [17].

Plastinated luminal casts specimens has advantages over the wet museum specimens as they are easy to carry, interpret, non-toxic, noninfectious low cost of preparation and storage. Plastination by luminal cast also provide useful alternative to artistic rendering to serve as basic image for animation. Although immersive VR systems are unlikely to replace cadaveric dissection [18], these low cost plastinated luminal casts tracheobronchial specimens has an advantage of providing dynamic information which otherwise is not being observed by the students.

In our low cost luminal cast plastination the cost of general purpose silicon sealant was one hundred and thirty each and cost of sheep lung was fifty rupees. There was no other additional cost of potassium hydroxide, hydrogen peroxide. The advantage of silicone sealant is that the procedure has to be carried out slowly and carefully as there was no immediate hardening which is caused due to epoxy resins and sine the specimens were kept immersed overnight in a bucket of water there was no decomposition. Hence this has been cheapest method of preparation of luminal cast specimen. This study has contributed dramatically to the development and delivery of two and three dimensional anatomical structure for anatomy education in the medical curriculum and

also to understand the variations before any procedures and surgical interventions.

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## Variation in the Relation of Recurrent Laryngeal Nerve to the Inferior Thyroid Artery: A Cadaveric Study

Megha Saknure\*, Charulata Satpute\*\*, Chandrashekhar Waghmare\*\*\*

### Abstract

Major complication of thyroid surgery is recurrent laryngeal nerve injury. Position of terminal branches of inferior thyroid arteries in relation to recurrent laryngeal nerve varies. The artery may lie posterior or anterior to the nerve or the main trunk of the nerve or its branches intermingle with the terminal branches of the inferior thyroid artery. *Aim:* To study the relation of inferior thyroid artery to recurrent laryngeal nerve. *Objectives:* To avoid the risk of nerve damage during thyroid surgery, a good knowledge of the variations of the recurrent laryngeal nerve is essential. The present study is an approach to objective to increase the information pool and help the clinicians and surgeons in their practice. *Material and Methods:* Present study includes total 100 thyroid glands from cadavers, embalmed with 10% formalin of known sex from Medical colleges. *Study Periods and Designs:* Between years Dec 2012 to Jan 2014. *Results:* Most common relation on right side was nerve intermingled with artery (NIA). Least common relation on right side was nerve posterior to artery (NPA). Most common relation on left side is nerve posterior to artery (NPA). Least common relation on left side was nerve intermingled with artery (NIA). When both sides were considered together, then the most common relation was nerve posterior to artery (NPA). Least common relation was nerve anterior to artery (NAA). *Conclusion:* If both sides of thyroid gland were considered together (n=200), the most common relation was nerve posterior to artery. Least common relation was nerve anterior to artery.

**Keywords:** Recurrent Laryngeal Nerve; Thyroid Gland; Inferior Thyroid Artery.

### Introduction

Thyroid surgery requires a thorough knowledge of the neck anatomy and its anatomical variations. This is of utmost importance, since it is well known that there are variations of the recurrent laryngeal nerve [1]. The course of recurrent laryngeal nerve (RLN) is determined by the pattern of development of the arteries with which it becomes related, and the variations of this pattern will determine variations in the anatomical disposition of this nerve [2].

Careful exploration and exact identification of the RLN reduce the risk of accidental nerve damage by 3 to 4 times. Most of the studies done regarding the anatomy of the RLN are cadaveric studies [3].

The vagus nerve is formed by the end of the fifth week of embryonic development and the branch that will originate the recurrent laryngeal nerve becomes apparent by the end of the sixth week. This branch of the vagus nerve is associated with the sixth branchial arch of the embryonic pharynx and it passes directly to the larynx. The embryo's system of aortic arches is associated with the pharynx. The vagus branch lies caudal to the aortic arches. With the embryo's development, the neck elongates, and the larynx moves cranially while the aortic arch and associated vessels remain in the thorax, and, with them, the vagus branch. This branch, reaching the larynx directly when first developed, now forms the adult's characteristic recurrent loop. Therefore the course of the recurrent laryngeal nerve is determined by the pattern of development of the arteries with which it becomes related, and the variations of this pattern

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will determine variations in the anatomical disposition of this nerve [4].

If the recurrent laryngeal nerve develops without alterations, it will originate from the vagus nerve and on the right side surrounds the right subclavian artery and on the left side surrounds the aortic arch. Before reaching its point of penetration in the larynx, the recurrent laryngeal nerve ascends in the neck in the tracheoesophageal groove in most of the cases [5].

Recently surgeons advocate the routine identification and dissection of recurrent laryngeal nerve to reduce its injury risk to minimum, and for endocrine surgeons it is unacceptable if recurrent laryngeal nerve is not identified during thyroid surgery[6].

## Material and Methods

The present study was carried out in the

## Observation and Results

**Table 1:** Side wise distribution of relation of recurrent laryngeal nerve (rln) and inferior thyroid artery (ita)

RLN	Right	Left	Right & Left together n (%)
NAA	29(29%)	17(17%)	46(23%)
NPA	22(22%)	72(72%)	94(47%)
NIA	49(49%)	11(11%)	60(30%)
TOTAL	100	100	200

(RLN- Recurrent Laryngeal Nerve, ITA - Inferior Thyroid Artery, NAA- Nerve Anterior to Artery, NPA- Nerve Posterior to Artery, NIA - Nerve In Between Artery.)

Table 1 shows the distribution of relation of Recurrent Laryngeal Nerve (RLN) to Inferior Thyroid Artery (ITA) on right and left side and on both side together.

Most common relation on right side was, NIA

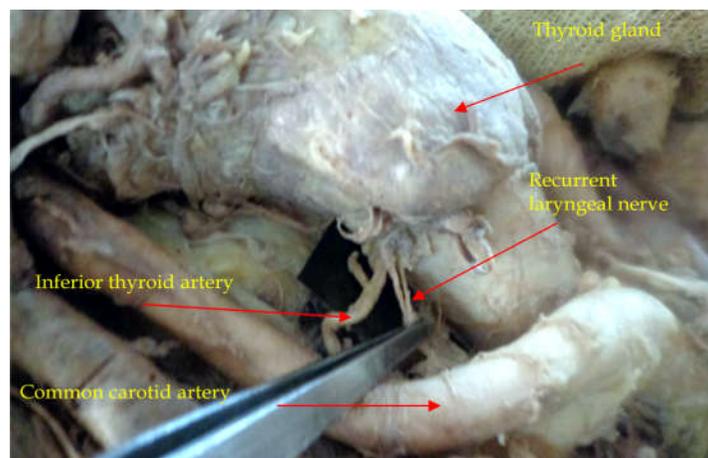
Department of Anatomy between years Dec 2012 to Jun 2014. The project was submitted to Independent Ethical committee of our college. After getting the approval letter from Independent Ethical Committee, the study was started. Present study includes total 100 thyroid glands from cadavers, embalmed with 10% formalin of known sex (62 Males and 38 Females) from GMC, IGGMC, LMMC, Nagpur.

Dissection method was employed for this study. The infrahyoid group of muscles were identified and reflected. The sternocleidomastoid muscle was displaced laterally and thyroid gland was exposed. The fascia was removed from the lobes of the thyroid gland, exposing its arteries and veins. The lower part of the gland was lifted up to expose the lateral surfaces of trachea and oesophagus with recurrent laryngeal nerve in the groove between them, along with the inferior thyroid artery. The relation between recurrent laryngeal nerve and inferior thyroid artery was noted and photographs were taken.

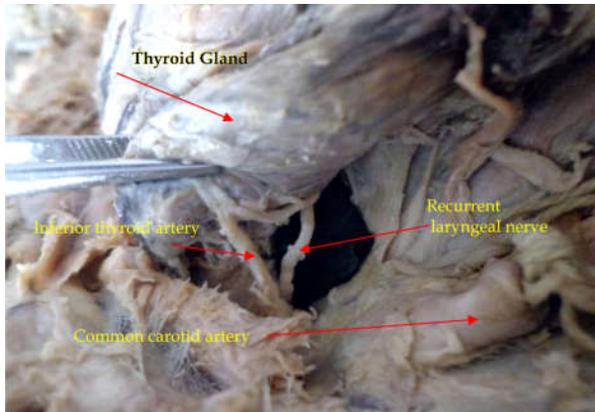
(n=49).Least common relation on right side was NPA (n=22).

Most common relation on left side is NPA (n=72). Least common relation on left side was NIA (n=11.)

When both sides were considered together, (n=200). Then the most common relation of nerve artery was NPA (n=94). Least common relation was NAA (n=46).



**Photograph 1:** Recurrent laryngeal nerve anterior to inferior thyroid artery



**Photograph 2:** Recurrent laryngeal nerve posterior to inferior thyroid artery.



**Photograph 3:** Recurrent laryngeal nerve in-between branches of inferior thyroid artery. Recurrent laryngeal nerve

### Discussion

Thyroid disorder is a common health problem among large number of endocrinopathies. About 5% of the world population is affected from various thyroid disorders. This requires medical and surgical intervention.

There is variation in the gross anatomy of the gland. Literature also replete with a large number of variations of the thyroid gland and relation between recurrent laryngeal nerve and inferior thyroid artery. Some conditions can cause recurrent laryngeal nerve (RLN) palsy [7,8]. Surgical injuries produce 11 to

32% of these [9,10]. Some procedures that may result in injury to the RLN are: thyroidectomies, parathyroidectomies, excision of Zenker’s diverticulum, esophagectomies, tracheoplasties, neck dissections, correction of a patent ductus arteriosum, mediastinoscopy [11].

Thyroidectomy is the surgery in which this injury occurs most frequently. The incidence of injury to the RLN in thyroidectomies ranges from 0 to 12% [12,13]. This injury occurs more frequently when a branch of the ITA is inadvertently sectioned. In an attempt to achieve hemostasis, the nerve is clipped and/or separated with the arterial branch [14,15].

**Table 2:** Comparison of relation of the right recurrent laryngeal nerve to inferior thyroid artery with other authors

Author	Year	Total No. of nerves studied	Nerve anterior to right inferior thyroid artery.	Nerve posterior to right inferior thyroid artery.	Nerve intermingled with the branches of right inferior thyroid artery.
Berlin D.D. & Lahey <sup>16</sup>	1929	21	18	3	–
Berlin D. <sup>17</sup>	1935	70	28	31	11
Weeks & Hinton <sup>18</sup>	1942	18	11	7	–
Bachhuber C. A. <sup>19</sup>	1943	52	18	33	1
Reed A.F. <sup>15</sup>	1943	250	65	68	117
Armstrong & Hinton <sup>20</sup>	1951	50	20	16	14
Bowden <sup>21</sup>	1955	28	8	9	11
Wade <sup>22</sup>	1956	93	16	37	40
Hunt, poole <sup>23</sup> et al	1968	74	28	40	6
Hirata K. <sup>24</sup>	1992	392	127	105	160
Lekacos <sup>25</sup> , et al	1992	109	19	52	38
Suresh N.M. <sup>26</sup> et al	2008	50	15	9	26
Saadeldin <sup>27</sup> et al	2013	82	52	22	8
Present study	2014	100	29	22	49

Table 2 present study showed that most common relation on right side was recurrent laryngeal nerve intermingled with the branches of the inferior thyroid artery (49%). Next common relation was nerve anterior to inferior thyroid artery (29%). The relation of nerve passing posterior to artery was relatively low. These finding seems to coincide with the work of

Hirata K [24] and Suresh N.M. [26] et al.

Table 3 Shows that on left side the relation of the recurrent laryngeal nerve posterior to the inferior thyroid artery was relatively high in present work (72%). Same findings were seen by Berlin [17], Bachhuber C.A [19]. Reed A.F. [15], Wade [22], Hunt & Pool [23] et al, Hirata k. [24], Lekacos [25] et al,

**Table 3:** Comparison of relation of the left recurrent laryngeal nerve to Inferior thyroid artery with other authors

Author	Year	Total No. of nerves studied	Nerve anterior to left inferior thyroid artery.	Nerve posterior to left inferior thyroid artery.	Nerve intermingled with the branches of left inferior thyroid artery.
Berlin D.D. & Lahey <sup>16</sup>	1929	23	4	19	–
Berlin D <sup>17</sup>	1935	70	17	44	9
Weeks & Hinton <sup>18</sup>	1942	20	7	11	2
Bachhuber C.A. <sup>19</sup>	1943	67	11	55	1
Reed A.F. <sup>15</sup>	1943	253	29	130	94
Armstrong & Hinton <sup>20</sup>	1951	50	14	27	9
Bowden <sup>21</sup>	1955	27	3	15	9
Wade <sup>22</sup>	1956	92	5	58	29
Hunt,poole <sup>23</sup> et al	1968	68	16	47	5
Hirata K. <sup>24</sup>	1992	392	19	258	115
Lekacos <sup>25</sup> ,et al	1992	82	12	45	25
Suresh N.M. <sup>26</sup> et al	2008	50	3	33	14
Saadeldin <sup>27</sup> et al.	2013	82	9	41	32
Present study	2014	100	17	72	11

Suresh N.M. [26] et al.

The next most common relation was the nerve anterior to artery. The least common relation was the nerve intermingled with the branches of the artery. This result correlates with result of Hunt [23] et al, Armstrong & Hinton [20], Bachhuber C A [19], Weeks & Hinton [18] et al ,Berlin D [17],Saadeldin et al. [27].

### Conclusion

Most common relation on right side was recurrent laryngeal nerve intermingled with the branches of the inferior thyroid artery (49%).

Most common relation on left side was recurrent laryngeal nerve posterior to the inferior thyroid artery was relatively high in present work (72%).

If both sides (right and left) of thyroid gland were consider together (n=200), the most common relation of nerve to artery was nerve posterior to artery. Least common relation was nerve anterior to artery.

Most of the diseases affecting the thyroid gland e.g. goitre, thyrotoxicosis, adenoma, carcinoma etc. are usually associated with enlargement of the gland and require medical and surgical intervention. There are many variations in the shape, size and relative level of the thyroid gland. Therefore, knowledge of the variation in morphological and topographical anatomy is very important in the evaluation and management of the thyroid disorders in clinical practice.

To avoid the risk of nerve damage during thyroid surgery, a good knowledge of the variations of the recurrent laryngeal nerve is essential. The present study is an approach to objective to increase the information pool and help the clinicians and surgeons in their practice.

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## A Study of Growth Pattern in Males and Females at Various Age Groups from Satara District of Maharashtra State

Sumedh G. Sonavane\*, Rupali R. Yadav\*\*, Dadasaheb D. Pawar\*\*\*

### Abstract

The growth of a child is of prime importance to all the parents in the world. Studies on growth and development of children in a community provide important information about the nutritional status of the community. Growth and development are unique in each person with limits of normalcy.

The present study was conducted on early adolescent children of following age groups.

i) 9 to 10 years, ii) 10 to 11 years and iii) 11 to 12 years.

The subjects selected for study were from the schools selected by random sampling from Rural and Urban areas of Satara District of Maharashtra State. The subjects consist of 1800 males and 1800 females of each age group from both H.I.G. and L.I.G; with total number of subjects are 3600.

Ten different anthropometric measurements were studied. Written informed consent from parents of subject and ascent of subject were obtained prior to the study. The present study was undertaken with the aim to comprehend the growth Patterns of early adolescent children of

1. The age group of 9 to 12 years.
2. School children belonging to both the genders.
3. Belonging to two different socio-economic strata.

Present study revealed that there is a difference in growth rate between the different age groups i.e. 9 to 10, 10 to 11, 11 to 12 years in the L.I.G. as well as in H.I.G. and there is a significant difference between Males and Females in these age groups and socio-economic groups. In almost all studies we have observed that H.I.G. values are always greater than L.I.G. values in all the age groups. The growth of L.I.G. can be increased up to the growth of H.I.G. with nutritional supplements. The data may be useful to the applicants to understand the growth pattern in school children of age group of 9 to 12 years as influenced by the socio-economic factors.

**Keywords:** Growth Pattern; Anthropometric Measurements; Early Adolescent Children.

### Introduction

The growth of a child is of prime importance to all

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the parents in the world. Studies on growth and development of children in a community provide important information about the nutritional status of the community.

Growth is an increase in size of body i.e. quantitative growth leading to physical maturation while development is maturation of function or quantitative growth leading to mental maturation [1].

Growth and development are unique in each person with limits of normalcy. The term growth and development used in the studies of physical growth is referred as a process not only intimately linked with time but also affected by following factors [1]:

1. Genetic factors

2. Environmental factors like climate and pollution
3. Demographic factors like ethnic origin and gender
4. Nutritional factors
5. Socio-economic status
6. Biological factors like chemicals, infectious drugs and emotional factors

In general Ontogenic growth implies an increase in size and mass, which results from synthesis of protoplasm an extracellular material which are specific tissue component [2].

Growth refers mainly to changes in magnitude increments in size of organs, increase in thickness of tissues or changes in size of an individual as a whole.

Human seems to be the only species to have a long quiescent interval between the rapid growth that takes place immediately after birth and the adolescent growth spurt [2].

Growth in height continues at a slower rate even after the adolescent growth spurts [3]. However weight gain is more variable.

Adolescence is a period of rapid growth and perhaps the last chance to grow. It is a transitional stage in human life. The exceptional rapid growth in this stage is characterized by a lot of individual variation that possess difficulty in defining normality.

The priorities of society have been based on infant morbidity and mortality rates. Adolescents have been overlooked by health planners, however recently their presence, care and counselling are coming to lime light. There is a high prevalence of malnutrition and anaemia among them.

The three dimensions of growth during adolescent are physical growth, mental or emotional blooming and sexual development. Most of the Indians especially the rural and the urban poor population fail to achieve the full-endowed genetic potential for growth and intelligence. This is due to sub optimum interaction of host factors with nutrition and environment. High prevalence of low birth weight babies and adolescent growth failure are indications of social deprivation.

Growth assessment is an essential component of health surveillance and gold standard for growth assessment in anthropometric measurements.

Adolescent growth reflects the adult size, the productivity of the future nation and even the size and health of future citizens. So it is important to give ample importance to adolescent nutrition and growth momentary.

The adolescent child should take a balanced diet. Nutrition of an adolescent girl should get priority, as she is the prospective mother. Improving the nutrition of the girl child will help to reduce the incidence of low birth weight babies.

The adolescent phase of the growth is equally important as childhood growth. Physiological changes during this period contribute immensely to the growth differences among the boys and girls.

Physical outcome in growth, form and shape manifest differently between both sexes. Therefore there is a need to study the pattern of physical growth in terms of growth dynamics, which work differently in each individual as among the males and females at different age groups.

Many environmental factors can contribute to the differences in growth, besides the genetic factors.

In India, socio-economic differences are highly prevalent and it is expected that such differences in the form of food resources would finally have their influence on growth outcome.

Present study is an attempt to provide anthropometric baseline data of early adolescent age group children amongst two contrasting socio-economic groups in randomly selected rural and urban areas of Satara district from the state of Maharashtra.

## Material and Methods

The study was carried on total 3600 subjects inclusive of the both sexes so also Higher and Lower socio-economic groups.

### *Socio-Economic Groups*

Ideally it is necessary to decide the economic status of each subject. However, it is extremely difficult to carry out such a survey because students as subjects for this study were not in a position to give their family income correctly. Thus it was decided to select those schools (Corporation/ Municipal/ Zhillia Parishad schools) in slum areas in and around Satara district, where the students belonged to the Lower socio-economic status/Lower income group (L.I.G.) generally opt to enrol. The English medium schools, specially run by the Christian missionaries, in elite areas in and around Satara district, on the contrary have majority of students (more than 95%) who belongs to the upper and middle class families/ Higher socio-economic status/Higher income group (H.I.G.) where the income is quite high.

The study was carried on total 3600 subjects inclusive of both sexes and both higher socio-economic status / Higher income group (H.I.G.) and lower socio-economic status / Lower income group (L.I.G.).

School registers, which had the record of date of births of subject's were considered as the reliable and feasible reference for the age.

*Other Criteria for Selection*

1. The Subject should be normal and healthy and

should not have any obvious body deformity.

2. The subject should hail originally from Rural and Urban areas of Satara District in Maharashtra State over three generations.
3. The subjects should be i) 9 to 10 years, ii) 10 to 11 years and iii) 11 to 12 years of age.
4. The subject should not have undergone any physical surgical procedures.
5. The subject should not have any history of trauma.

**Table 1:** Distribution of sample size

Age (years)	Male		Females	
	H.I.G.	L.I.G.	H.I.G.	L.I.G.
9-10	300	300	300	300
10-11	300	300	300	300
11-12	300	300	300	300
<b>Total</b>	<b>900</b>	<b>900</b>	<b>900</b>	<b>900</b>

Total No. of Subjects = 3600

Males = 1800

Females = 1800

Written informed consent from the parents (as all subjects are minor) and ascend from subjects were obtained prior to the anthropometric measurements.

*Following Measurements were Taken on the Subjects for the Study*

1. Height vertex (cm)
2. Sitting Height vertex (cm)
3. Head circumference (cm)
4. Chest circumference (cm)
5. Waist circumference (cm)
6. Mid-arm circumference (cm)
7. Mid-thigh circumference (cm)
8. Weight (Kg)
9. Skin fold thickness-mid arm (cm)
10. Skin fold thickness-mid thigh (cm)

All mentioned measurements were taken and recorded by the same person by calibrated anthropometric instruments and standard anthropometric techniques. An average of the three readings was considered for every measurement to minimize the error.

*The following Index was also Calculated for Comparison*

1. Body Mass Index (BMI)

$$BMI = \text{Weight (kg)} / \text{Height (mts)}^2$$

*The Instruments Used*

1. Anthropometric Rod
2. Skinfold Calliper
3. Flexible measuring tape
4. Weighing Balance

*Body Mass Index (B.M.I.)*

The body mass index is calculated as weight (kg) per height. Height (mt)<sup>2</sup>.

i.e.  $B.M.I = \text{Weight (kg)} / \text{Height (mt)}^2$

As mentioned by K.E.Elizabeth,<sup>1</sup> B.M.I. of 18.5 is considered as normal but in our Adolescent group especially below 13 years, B.M.I. is always less than 18.5. In Indian's the normal value of B.M.I. is 15. If it is less than 15 it indicates chronic energy deficiency or underweight and if it still less than 13 is indicates serves underweight [1].

*Observations*

Observations of the present study are as follows.

1. In H.I.G. all the ten parameters showed much higher values in all the three age groups, 9 to 10 yrs;10 to 11 yrs. and 11 to 12 yrs. than L.I.G.
2. For Height vertex values, there is an increase in height values in both the boys and girls of H.I.G. There is a similar trend observed in Boys and girls of L.I.G. Baselines of increase in height are

different. Growth spurt of boys is later than that of girls in both H.I.G. & L.I.G. Growth spurt in height of girls is seen at 10 to 11 yrs. in both H.I.G. & L.I.G. Growth spurt in height of boys is seen in 11 to 12 years in both H.I.G. & L.I.G.

3. For sitting height vertex values, there is an increase in sitting vertex values in boys and girls of H.I.G. and L.I.G. from 9 to 12 years. Growth spurt in sitting height is seen at 10 to 11 years in boys and girls in H.I.G. and 11 to 12 years in boys and girls in L.I.G.
4. Head circumference is maximum at 11 to 12 years in boys of H.I.G. and L.I.G. Maximum head circumference is observed at 9 to 10 years in girls of L.I.G. and at 10 to 11 years in girls of H.I.G. Decreasing values are seen in 10 to 11 years of boys and girls of L.I.G. Decreasing values are seen in 11-12 years of girls in H.I.G. The values at 10 to 11 yrs. of girls in H.I.G. have decreased in 11 to 12 years. Decreasing values could be explained on the basis that the studies are cross-sectional. Therefore Head circumference is not a good parameter to be considered in growth studies.
5. Growth in chest circumference is more significant in females than in the males, which is obvious due to Breast development in females. But in the females of H.I.G. group this chest circumference is more than females of L.I.G. group.
6. The females show steady growth in waist circumference irrespective of socio-economic groups. The values are much higher in H.I.G. as compared to L.I.G. This difference could be because of consumption of more fatty food by H.I.G. children; this is evident from the data collected about dietary intake.
7. Growth of mid-arm circumference is maximum at 10 to 11 years in males and females of H.I.G. and at 11 to 12 years in males and females in L.I.G.

Thus for the growth of mid-arm circumference, the High socio-economic groups show the same pattern in both the sexes, while there is a steady growth in mid-arm circumference in males and females Low socio-economic group.

8. The mid-thigh circumference also showed maximum value in H.I.G. at 10 to 11 years in both sexes, while in L.I.G. the values of mid-thigh circumference are steadily increasing from 9 to 12 years.
9. There is a growth spurt in weight at 10 to 11 years in females of H.I.G. This is maintained even up to the next age group of 11 to 12 years in females, where fat deposition is more before the onset of menarche. The growth spurt in weight in females of L.I.G. is observed at 11 to 12 years.  
  
In the males of L.I.G. the more weight gain is seen at 11 to 12 years, while in males of H.I.G. the growth spurt of weight is seen in 10 to 11 years of age.
10. There is a clear difference in values in mid-arm skin - fold thickness in H.I.G. and L.I.G.  
  
In males, the mid-arm skin fold is thicker at 10 to 11 years of age in H.I.G. while at 9 to 10 years of age in L.I.G. In the male L.I.G. group, skin fold thickness is reduced at a later age (11 to 12), may be due to acceleration in height during the same period.  
  
In girls, the mid arm skin fold is thicker at 10 to 11 years of age in H.I.G. at 11 to 12 years of age in females of L.I.G.
11. Thickness of mid-thigh skin fold is maximum at age of 10 to 11 years in both sexes H.I.G. while it is maximum at 11 to 12 years in both sexes of L.I.G.
12. B.M.I. is highest in 11 to 12 years of H.I.G. in both sexes, while highest at 9 to 10 years in Boys of L.I.G. and 11 to 12 years in girls of L.I.G. The differential weight gain as well as growth spurt due to increase in height during the adolescent

**Table 2:** Showing works of different indian researchers

Sr. No.	Name of Researcher	Title of the Topic	Year and State
1.	M.V. Phadke <sup>11</sup>	Growth norms in Indian Children	1967, Maharashtra
2.	K.D. Mohanta <sup>12</sup>	Anthropometric measurements of children of Western Orissa	1971, Orissa
3.	B. Bhandari et al <sup>13</sup>	Nutritional anthropometry of rural school children of Udaipur District	1972, Udaipur (Rajasthan)
4.	N.K. Dutta et al <sup>14</sup>	Growth pattern of Indian school children in relation to nutrition and adolescence	1972, Delhi
5.	Vijay Raghavan et al <sup>15</sup>	Height and Weight of well nourished Indian school Children.	1971, Hyderabad (A.P.)
6.	Vijay Raghavan <sup>16</sup>	Arm circumference and fat fold at triceps in well nourished Indian school children	1973, Hyderabad (A.P.)
7.	S.K. Bhasin et al <sup>18</sup>	Skin fold thickness in well nourished school children in Haryana	1990, Haryana
8.	Satipati Chatterjee et al <sup>19</sup>	Physical growth pattern for girls (9-17) from rural West Bengal	1991 West Bengal

**Table 3:** Height Vertex (cm): Comparison of height vertex with other similar studies

Groups (years)	Present Study		(2015)		M.V. Phadake <sup>11</sup> (1967)		B. Bhandari <sup>13</sup> (1971)		N. Datta et al <sup>14</sup> (1972)		S. Chatterjee <sup>8</sup> (1991)		
	H.I.G.	F	M	L.I.G.	H.I.G.	F	M	H.I.G.	F	M	H.I.G.	L.I.G.	
	133.47	129.10	116.64	116.64	-	-	-	118.4 ± 20.1	132.05	133.84	127.05	126.04	
	136.37	140.04	122.11	122.11	128.9	129.7	127.2	124.1 ± 23	134.09	138.58	131.80	130.62	
	141.70	143.82	132.75	126.52	-	-	-	130.2 ± 15	143.94	143.06	136.73	136.25	
												126.49 ± 5.05	
													131.66 ± 5.56
													137.29 ± 6.21

**Table 4:** Sitting Height Vertex: (cm), Comparison of sitting height vertex with other similar studies:

Age Group (yrs.)	Present Study (2015)		B. Bhandari <sup>13</sup> (1971)		S. Chatterjee <sup>8</sup> (1991)	
	H.I.G.	F	M	L.I.G.	H.I.G.	L.I.G.
9-10	63.60	62.57	57.18	57.45	59.9±9.6	67.00±2.68
10-11	70.57	66.46	59.31	60.58	62.50±8.8	68.55±2.84
11-12	74.00	70.05	63.03	64.57	64.5±8.2	71.01±3.31

**Table 5:** Head Circumference: (cm), Comparison of head circumference with other similar studies:

Age Group (yrs.)	Present Study		(2015)		B. Bhandari <sup>13</sup> (1971)	
	H.I.G.	F	M	L.I.G.	H.I.G.	L.I.G.
9-10	51.80	51.14	50.68	50.82	48.4±5.2	-
10-11	52.62	52.67	50.12	49.46	48.9±5.4	-
11-12	52.64	50.37	51.10	50.76	49.0±4.4	-

**Table 6:** Chest Circumference: (cm), Comparison of chest circumference with other similar studies:

Age Group (yrs.)	Present Study (2015)		L.I.G.		B. Bhandari <sup>13</sup> (1971)	
	H.I.G.	F	M	F	H.I.G.	L.I.G.
9-10	57.90	58.99	55.19	54.67	56.1±8.4	-
10-11	60.89	61.81	58.31	58.56	55.4±10	-
11-12	62.92	63.67	58.44	60.48	54.2±11	-

**Table 7:** Mid- Arm Circumference: (cm)  
Comparison of Mid-Arm Circumference with other similar studies

Age Groups (years)	Present Study (2015)		Vijay Raghvan <sup>15</sup> (1971)		B. Bhandari <sup>13</sup> (1971)		N. Datta <sup>14</sup> (1972)					
	H.I.G. M	L.I.G. F	H.I.G. M	F	H.I.G. M	F	H.I.G. M	F				
9 to 10	18.62	18.03	17.05	15.73	18.55± 2.29	18.75± 2.44	15.97± 1.26	16.20± 2	18.61	18.47	16.30	15.94
10 to 11	20.65	21.06	17.27	17.93	18.98 ± 2.41	19.28± 2.26	16.50 ± 1.16	16.00 ± 4	20.00	19.61	17.90	17.86
11 to 12	19.82	20.88	17.76	19.08	19.58 ± 1.28	19.78 ± 2.31	16.86 ± 1.25	17.2 ± 2	20.43	20.86	18.45	18.40

**Table 8:** Mid-arm Skin fold thickness: (cm)  
Comparison of Mid- arm Skin- fold thickness with other similar studies:

Age Group (yrs.)	Present Study		Vijay Raghavan <sup>16</sup> (1973)		S.K. Bhasin <sup>17</sup> (1990)	
	H.I.G. M	L.I.G. F	H.I.G. M	F	H.I.G. M	L.I.G. F
9-10	0.62	0.80	0.54	0.49	0.922	1.1
10-11	1.11	1.15	0.43	0.50	0.95	1.11
11-12	1.04	1.10	0.48	0.56	0.95	1.11

**Table 9:** Weight: (Kg)

Age Groups (years)	Present Study		M.V. Phadake <sup>11</sup> (1967)		B. Bhandari <sup>13</sup> (1971)		N. Datta <sup>14</sup> (1972)		S. Chatterjee <sup>18</sup> (1991)			
	H.I.G. M	L.I.G. F	H.I.G. M	F	H.I.G. M	F	H.I.G. M	L.I.G. F	H.I.G. M	L.I.G. F		
9 to 10	27.69	28.17	22.62	20.58	-	-	23.30	-	28.85	27.82	25.27	24.68
10 to 11	33.97	34.09	21.70	22.48	23.3	21.3	20.20	-	31.55	30.37	27.43	27.02
11 to 12	34.11	35.64	25.68	28.23	-	-	25.00	-	34.06	34.48	29.06	28.27

period may be the reason for such variations.

**Discussion**

History of study of growth patterns in growing children dates back to 1502 done by Gabreilade Zerbis [3]. He published Anatomic differences between a child and an Adult.

The credit for advocating the term, 'Anthropometry' goes to the Belgian astronomer statistician Lambert Aldolphe Jacques Quelelet (1796-1874) [4]. His study was the first complete study of physical growth of children. He had extensive study of heights and weights of male and female subjects of all ages.

Growth studies in Adolescents was done in detail by Vierordt (1818-1884) [5] of Tubingen, along with Bowditch [6] recognized the adolescent spurt and also that the girls entered this period sooner than boys. Tanner [7,8] has made particularly large contributions on the subject of the adolescent.

Anthropometric studies are now being carried out in India on large scale. Other anthropometric reports from ancient India is from 'Archeological

Survey of India', stated by Penniman T.K. (1965) [9].

Indian Council of Medical Research (I.C.M.R.-1960) [10] published the report on the growth and development of Indian infants and children.

The purpose of present study is aimed at throwing light on growth patterns in early adolescent children in and around Satara District of both H.I.G. and L.I.G. socio-economic status.

Future of India is dependant on the physical and mental growth of the children. India being a developing country shows a great diversity in its socio-economic status, which would further reflect on the growth pattern of the children. Knowledge of growth pattern of the children is therefore imperative. Healthy children apart from developing into healthy adults and parents can also play a key role in social and health education of their younger sibling and uneducated parents. Studies of growth and development of children in a community provide important information about the nutritional status of the community.

Adolescence is a period of rapid growth. It is a transitional stage in human life. Hence this age group should be well attended and looked after. The accurate assessment of physical growth and development of children has recently created interest in the paediatricians and public health officers. In the developed countries, infectious diseases are well controlled. Their attention has now diverted to correction of disorders of growth as a primary symptom or associated with some metabolic defect. In the developing countries children's growth is now widely recognized as a sensitive index of health and nutrition of the population. Therefore W.H.O is stressing upon the health programs of pre-pubertal and adolescent boys as well as girls. This data will assist in preparing various health programs.

Children of low socio-economic group income group lag very much behind the High socio-economic group. These underprivileged children are constantly exposed to severe nutritional, social and environmental strains as revealed in the present study and the studies done earlier.

Nutritional Anthropometry is concerned with measurement of variations in the physical dimensions and the gross composition of the human body at different ages. It is one of the most important tools in assessing the nutritional status of a community or a nation, which is of great value in guiding public programs.

For establishing growth pattern, standard parameters like Height, Weight, Mid-arm skin fold, Head circumference, Chest circumference, Waist

circumference are studied.

In the present study in addition to the above parameters skin fold thickness of mid-thigh is measured. Skin fold thickness is a good indicator of the nutrition of a person and its measurement by a standard method provides a reliable index of the amount of body fat. This method can be easily applied in field for the study of large population samples for prevalence of obesity as well as to provide an additional parameter of under nutrition. Their measurement forms an essential part of assessment of physique. So far, Western standards have been used for comparison purposes. From the physiologic viewpoint, normal growth in its inception, maintenance and termination depends upon an orderly sequence of genetic, constitutional, environmental, nutritional and endocrine influences. In this context, using Western standards may have the inherent drawback as children are living under different environment and belonging to a different racial stock. Therefore in the present study, the data is compared with Indian researchers who have done their research on Indian population.

The following discussion is based on comparison, with other studies available in India.

India has diverse population of having racial, dietic and economic differences.

Various researchers of different communities have done the studies using different parameters as follows.

The study also provides a comparative picture with those similar studies undertaken from 1967 to 1991. It is now well established that all populations in the world are undergoing temporal changes with reference to body measurements mainly caused by the life style changes and better nutritional food intake.

In the Higher income group children in the urban area, it has seen that lots of efforts are taken in terms of exercises and food regulation for maintenance of specific desired body dimensions.

The values for the above measurements are compared in both genders of H.I.G. and L.I.G. in three age groups.

There is a wide heterogeneity observed amongst the Indian population across the expanse of the country, as well as between rural urban divide.

The present data also shows such a variation because the comparative data comes from heterogeneous parts. However, the overall temporal changes are clearly observable from these tables.

A few discrepancies are observed in

measurements. This is because the selection of the school children is based on only one criterion that is economic status. However within the same age group cohorts there can be children belonging to different caste or religious groups, who may have different body dimensions. The fluctuations that we observe here in different age groups could be due to samplings error.

Because of the optimum sample size the values of different anthropometric parameters derived at various age groups of both the sexes in both H.I.G. and L.I.G. socio-economic status in and around Satara District, Maharashtra State, may serve as useful reference by applicants.

Manufacturers of daily objects and wear, forensic experts and concern authorities in the field of anthropometry of 21<sup>st</sup> century are the important beneficiaries of these findings.

### Summary and Conclusion

From 'Birth' to 'Death', there exists a period of growth and development. In children growth, development and nutrition are intricately inter-linked. One aspect tends to influence the other significantly. Malnutrition is a 'man-made disease', which often starts in the 'Womb' and ends in the 'Tomb'. Malnutrition and the associated retarding influences cause a lot of morbidity, growth faltering, developmental retardation and significant mortality. The ultimate expression of endowed potential for growth and intelligence is the net effect of interplay of genetic factors, nutrition and environment.

Globalization has made the people of world come closer. India is progressing with great leaps and bounds in all fields. With the progress of the country, level of the economic disparity among the people could be hopefully levelled.

Healthy children will develop into healthy adults and thus play a key role in development of our country, India. Hence the adolescent child health is a very important and prime concern of the nation. The Adolescent girl should get priority, as she is the prospective mother and thus can produce the next generation of healthy babies. This will also result in reducing the low birth weight babies by improving the nutrition of the girl child.

Studies on Adolescent growth are few. The present study attempts to understand the growth variations between genders, belonging to two different socio-economic groups.

In all 3600 school children belonging to 9 to 12 age

groups were subjected to ten Anthropometric measurements and three indices. Schools were selected by random sampling according to socio-economic status however schools of elite areas of Satara district were selected by random sampling for High socio-economic group (H.I.G.), for both sexes and Municipal Corporation/ Zilla Parishad schools in slum and Rural, below poverty line areas of Satara district were selected for Low Socio-economic group for both sexes. L.I.G. and H.I.G. were studied through anthropometrical parameters and the results clearly divide these two groups.

Thus to conclude,

The present study was undertaken with the aim to comprehend the growth Pattern of -

1. School children in the age group of 9 to 12 years.
2. School children belonging to both sexes.
3. Belonging to two different socio-economic strata.

Present study shows...

1. There is a difference in growth rate between the different age groups i.e. 9 to 10, 10 to 11, 11 to 12 years in the L.I.G. as well as in H.I.G.
2. There is a significant difference between Males and Females in these age groups and socio-economic groups.
3. Girls of both H.I.G. and L.I.G. show growth spurt in Height earlier than boys of H.I.G. and L.I.G.
4. Growth in Chest is more in females than males in both socio-economic groups.
5. Growth spurt in mid-arm circumference, mid-thigh circumference, mid-arm skin fold thickness, mid-thigh skin fold thickness is earlier at 10-11 years in both male and female, which shows decrease thereafter in the above values in 11 to 12 years groups. While steady increase in the growth is observed in the mid-arm and mid-thigh circumference in Males and Females of L.I.G. Therefore a pattern of growth of mid-arm circumference and mid-thigh circumference is similar in H.I.G. and L.I.G.
6. B.M.I. is highest in 11 to 12 years in both sexes of Higher socio-economic group (H.I.G.). It is always more than 15 kg/m<sup>2</sup> which are normal value of B.M.I. for Indians.
7. The B.M.I. observed in both sexes of L.I.G. in age group of 10 to 11 years has decreased which shows underweight (less than 15 kg/m<sup>2</sup>) but it is above 13 kg/m<sup>2</sup> (a value for severe

underweight), which can be corrected by nutritional supplements.

Until now mid-arm circumference and mid arm skin fold thickness were the parameters taken by different researchers. After studying mid thigh circumference and mid thigh skin fold thickness as different parameters it is seen that their values go parallel with that of mid-arm circumference and mid-arm skin fold thickness in both L.I.G. and H.I.G. groups. So these two new parameters i.e. mid thigh circumference and mid thigh skin fold thickness can be added in further studies.

In almost all studies we have observed that H.I.G. values are always greater than L.I.G. values in all the age groups. The growth of L.I.G. can be increased up

to the growth of H.I.G. with nutritional supplements.

The data may be useful to the applicants to understand the growth pattern in school children of age group of 9 to 12 years as influenced by the socio-economic factors.

### Acknowledgement

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### ANNEXURE - I

#### Proforma for Collection of Anthropometric Data

Case No.: ..... Date of Anthropometric Measurements: / /

Name of the Subject: .....

Name of the School: .....

Gender: Male / Female

Date of Birth: ...../ ...../ ....., Age: .....years.

Age Group: 9 to10 years / 10 to11 years / 11 to 12 years.

Area: Rural/Urban

Socio-economic Status: L.I.G. / H.I.G.

No. of generations in the Satara District (Maharashtra State): .....

#### Measurements:

1. Height vertex = .....cms
2. Sitting Height vertex = .....cms
3. Head circumference = .....cms
4. Chest circumference = .....cms
5. Waist circumference = .....cms
6. Mid-arm circumference = .....cms
7. Mid-thigh circumference= .....cms
8. Weight =..... kgs.
9. Skin fold thickness-mid arm = ..... cms
10. Skin fold thickness-mid thigh = .....cms
11. B.M.I.= .....

**ANNEXURE - II  
CONSENT FORM**

(Parent /s /Guardian should fill the consent form as all subjects are minor)

I ..... / We ..... and  
..... Age: ..... years and ..... years. (Name of child:  
..... Age: ..... years)

Address: .....

Hereby state that, I / We have been fully explained about the procedure of external anthropometric measurements of my / our child.

I / We give my / our full consent for the same.

I / We also allow him to take my / our child's photographs of body measurements as a part of documentation for scientific research.

I / We also give my / our full consent to use my / our child's photographs of body measurements for research purpose, scientific publications and presentations in scientific forums.

Name /s and Signature /s of the Consultands:

1. Name: ..... Signature: .....  
2. Name: ..... Signature: .....

Witness to Consent:

Name: ..... Signature: .....

Place:

Date: / /

**ANNEXURE - III  
SUBJECT/VOLUNTEER'S ASSENT FORM**

(Assent will be taken of 7 to 15 years of age)

I ..... Age: ..... Years. Freely willing to be as a participant  
in the present study entitled "*A Study of Growth Pattern In Males and Females at Various Age Groups From Satara District of Maharashtra State*"

(Name of child: .....) )

Address: .....

Gender: Male / Female

Date of Birth: .... / .... / .....

Age: ..... years

Name of school: .....

1. I have understood the information sheet dated for above study: **YES/NO**
2. I understood that my participation in the study is voluntary: **YES/NO**
3. I understood that my identity will not be revealed: **YES/NO**
4. I allow to take my body measurements: **YES/NO**

Name of Assenter: ..... Signature: .....

Name of Parent: Mr./ Mrs. .... Signature: .....

Name of Witness: ..... Signature: .....

Name of Investigator: ..... Signature: .....

Place: .....

Date: ... / ... / .....

#### ANNEXURE - IV

##### Abbreviations:

1. H.I.G.: - High Income Group L.I.G.: - Low Income Group
2. i.e. - That is
3. Lt. - Left
4. Rt. - Right
5. Min. - Minimum
6. Max. - Maximum
7. Avg. - Average
8. mm - Millimeters
9. Cm - Centimeters
10. Ht. - Height
11. B.M.I. - Body Mass Index
12. No. /s - Number/Numbers

##### Conflicts of Interest

All authors have none to declare.

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## A Morphometric Study of the Glenoid Cavity of the Scapula

Azhar Ahmed Siddiqui\*, Zuberi Hussain Riyaz\*\*

### Abstract

*Aim:* To study glenoid morphology, its anatomical patterns and variations in Maharashtra Population to establish possible morphofunctional correlations related to race, geographic region and literature data. *Materials and Methods:* One hundred scapulae of unknown age and sex were studied. Morphological shapes of the glenoid were evaluated. The various diameters of glenoid cavity were measured. Statistical Analysis was done. *Results:* In the present study, the mean value of Superior-Inferior diameter (A) of the glenoid cavity on the right side was  $40.82 \pm 2.88$  mm and on the left side was  $39.49 \pm 2.72$  mm. The mean Anterior-Posterior glenoid diameter (B) was  $22.95 \pm 2.06$  mm on right side and  $21.66 \pm 2.08$  mm on left side. The mean Anterior-Posterior glenoid diameter (C) was  $29.08 \pm 2.80$  mm on right side and  $28.09 \pm 2.58$  mm on left side. The shapes of glenoid cavities studied were oval [45%], pear shaped [34%] or inverted comma shaped [21%]. *Conclusion:* Variations in the size and shape of the glenoid cavity observed in the current study will be of great help for orthopaedic surgeons to understand the shoulder pathology better and to decide the proper size of the glenoid component for the shoulder arthroplasty.

**Keywords:** Morphometric Study; Glenoid Cavity; Scapula.

### Introduction

The scapula (shoulder blade) is a triangular flat bone that lies on the posterolateral aspect of the thorax, overlying the 2<sup>nd</sup> to 7<sup>th</sup> ribs. The convex posterior surface of the scapula is unevenly divided by the spine of the scapula into a small supraspinous fossa and a much larger infraspinous fossa. The concave costal surface of the scapula has a large subscapular fossa. The triangular body (blade) of the scapula is thin and translucent superior and inferior to the scapular spine [1]. The lateral angle of Scapula is truncated and bears the glenoid cavity for articulation with the head of the humerus. This part of the bone may be regarded as the head [2].

The phylogenetic, ontogenic and racial variations of the scapula make it as one of the most interesting

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bones for research [3]. Moreover, the meticulous dimensions of the scapula are of major importance in the patho-mechanics of rotator cuff disease, total shoulder arthroplasty and recurrent shoulder dislocation [4]. Based on the presence of a notch on the anterior glenoid rim, the shapes of the glenoid cavity have been classified into: pear shaped; inverted-comma shaped and oval shaped [5]. Moreover, the inclination of the glenoid has been associated with full thickness rotator cuff tears [6]. Therefore, the variations of shape and size of glenoid cavity of scapula is important for the understanding of shoulder dislocation, rotator cuff disease and to determine the meticulous size of the glenoid component in the shoulder arthroplasty and has a prognostic value on the primary gleno-humeral osteoarthritis [7].

The purpose of the current study was to record the morphometrical data for the glenoid cavity of the scapula specifically and to study the various shapes of the glenoid cavity in the Maharashtra population and to compare the data obtained from the present study with those of other populations in order to establish possible morphofunctional correlations related to other state and literature data. Moreover, these data could have clinical role for better

understanding and management of shoulder pathology; gleno-humeral instability, orthopedic joint replacement and rotator cuff tears management.

### Materials and Methods

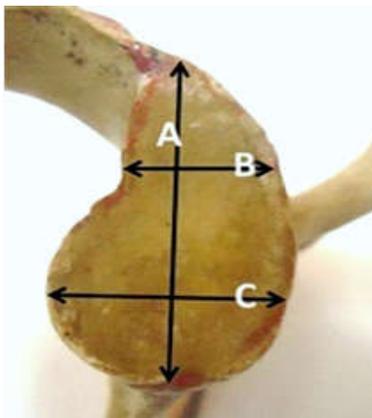
One hundred (100) dry adult human scapulae were studied from Department of Anatomy at IIMSR, Warudi, Badnapur, Jalna. The bones were completely ossified; unbroken; intact and devoid of any deformity or damage, the exact ages or genders were not known. Out of the 100 scapulae, 50 belonged to the right side and 50 belonged to the left one. Each scapula underwent a morphological evaluation and osteometric measurement for glenoid cavity. The mean and standard deviation of the glenoid cavity in various dimensions were calculated. Statistical Analysis: The morphometric values of the two sides were analysed using an unpaired t-test. Statistical significance was set as  $\leq 0.05$ . The data were analyzed using the SPSS Software. Following parameters of glenoid cavities were used.

#### Morphological

The shapes of the glenoid cavity were studied and categorized as oval, pear shaped or inverted comma shaped. These were confirmed as follow; A piece of white sheet was placed on the glenoid cavity and held firmly in position to trace the shape of the glenoid cavity. The side of the point of a lead pencil was rubbed along the rim of the glenoid cavity to get a tracing of the shape of the glenoid cavity on the paper.

#### Osteometric Evaluation

I) Superior-Inferior glenoid diameter (A) is the maximum distance between the inferior point of the



**Fig. 1:** Showing various diameters of the glenoid cavity. A: Superior-Inferior diameter; B: Anterior-Posterior diameter (AP-1); C: Anterior-Posterior diameter (AP-2)

glenoid border and the most prominent point of the supraglenoid tubercle [Figure 1]. II) Anterior-Posterior glenoid diameter (B) is the maximum breadth of the articular margin of the glenoid cavity perpendicular to the glenoid cavity height [Figure 1]. III) Anterior-Posterior glenoid diameter (C) is the anterior-posterior diameter of the superior half of the glenoid cavity at its mid-point (Figure 1). All these measurements were taken in millimeters using sliding digital vernier caliper (Figure 2).



**Fig. 2:** Photograph showing method of measuring superior-inferior Diameter of glenoid cavity

### Results

In the present study, the mean value of Superior-Inferior diameter (A) of the glenoid cavity on the right side was  $40.82 \pm 2.88$  mm and the left side was  $39.49 \pm 2.72$  mm. The mean Anterior-Posterior glenoid diameter (AP-1), B was  $22.95 \pm 2.06$  mm on right side and  $21.66 \pm 2.08$  mm on left side. The mean Anterior-Posterior glenoid diameter (AP-2), C was  $29.08 \pm 2.80$  mm on right side and  $28.09 \pm 2.58$  mm on left side (Table 1).

The shapes of glenoid cavities studied are oval, pear shaped or inverted comma shaped (Figure 3). Out of the 50 right side glenoid cavities 10 were found to have inverted comma shape the incidence of this shape was found to be 20%. The number of glenoid cavities having pear shape on the right side was 18 and the incidence was found to be 36%. Oval glenoid cavities were 22 in number on the right side and the incidence was 44%. On the left side, glenoid cavities

with the inverted comma shape were observed to be 11 in number out of the total 50 scapulae examined and the incidence of inverted comma shaped glenoid was 22%. The pear shape glenoid cavities were

observed to be 16 similarly 23 were oval on the left side. Incidence of pear shaped glenoid was 32% and that of oval glenoid cavities was 46% respectively (Table 2).

**Table 1:** Measurements of various diameters of right and left glenoid Cavity

Parameters	Right side Mean $\pm$ SD	Left side Mean $\pm$ SD	Total mean Mean $\pm$ SD	P value
Superior-inferior glenoid diameter (A)	40.82 $\pm$ 2.63	39.49 $\pm$ 2.73	39.52 $\pm$ 2.80	0.394
Anterior-posterior glenoid diameter 1 (B)	22.62 $\pm$ 2.06	21.66 $\pm$ 2.08	21.85 $\pm$ 2.68	0.470
Anterior-posterior glenoid diameter 2 (C)	29.08 $\pm$ 2.80	28.09 $\pm$ 2.60	28.90 $\pm$ 2.58	0.90

**Table 2:** Various shapes of right and left glenoid cavities

Shape of glenoid cavity	Right side		Left side		Total mean	
	No	%	No	%	No	%
Oval	22	44	23	46	45	45
Pear	18	36	16	32	34	34
inverted comma	10	20	11	22	21	21



**Fig. 3:** Photograph showing various shapes of the glenoid cavity

## Discussion

Many studies have attempted to determine the glenoid diameters in a variety of ways, including direct measurement of dry scapulae, direct measurement of fresh or embalmed cadavers, radiographic measurement of scapulae harvested from cadavers and radiographic measurement in living patients. The present study was done on dry human scapulae obtain from cadavers. The results of present study were compared with those of previous workers. In the present study the mean superior inferior diameter (A) of the right glenoid cavity was 40.82  $\pm$  2.88 mm and the mean superior-inferior diameter of the left side was 39.49  $\pm$  2.72 mm. Though the right glenoid value was slightly more on right

side but was statistically not significant. The mean values of present study were compared to the values recorded in other studies (Table 3). Mallon *et al* (1992) [8] studied 28 glenoid cavities they found mean SI to be 35  $\pm$  4.1 mm. Similarly, Karelse *et al* (2007) [9] found mean SI to be 35.9  $\pm$  3.6 mm. (Both these values were nearly same as that of present study).

Iannotti *et al.* (1992) [10] and Von Schroeder *et al.* (2001) [11] reported the superior-inferior diameter of the glenoid to be 39  $\pm$  3.5 mm and 36  $\pm$  4 mm respectively which were more than the present study. Mamtha *et al* (2011) [12] in their study performed on 98 right and 104 left sided scapulae found that mean SI diameter on right and left side were 33.67  $\pm$  2.82 mm and 33.92  $\pm$  2.87 mm respectively which were comparatively lower than present study (Table 3).

**Table 3:** Comparison of Superior-Inferior diameter by various studies

Observers	No of specimens	Mean SI Diameter A
Mallon <i>et al</i> (1992) <sup>8</sup>	28	35 ± 4.1 mm
Iannotti <i>et al</i> (1992) <sup>10</sup>	140	39 ± 3.5 mm
Von Schroeder <i>et al</i> (2001) <sup>11</sup>	30	36 ± 4 mm
Karelse <i>et al</i> (2007) <sup>9</sup>	40	35.9 ± 3.6 mm
Mamtha <i>et al</i> (2011) <sup>12</sup>	Right-98	33.67 ± 2.82 mm
	Left-104	33.92 ± 2.87 mm
Present Study (2015)	Right-50	40.82 ± 2.88 mm
	Left-50	39.40 ± 2.72 mm

In present study the mean anterior-posterior diameter (AP-1) (B) of the lower half of the glenoid of the right side was  $23.95 \pm 2.78$  mm and that of the left side was  $23.64 \pm 2.37$  mm. The right glenoid was broader than the left glenoid. This was very close to what was observed in the study of Mamtha *et al* (2011) [12] in which they found that the mean AP-1 diameters on right and left sides were  $23.35 \pm 2.04$  mm and  $23.02 \pm 2.30$  mm respectively. Studies carried out by Iannotti *et al* (1992) [10] on 140 scapulae, Von Schroeder *et*

*al* (2001) [11] on 30 scapulae and Karelse *et al* (2007) [8] on 40 scapulae found AP-1 diameter to be  $29 \pm 3.2$  mm,  $28.6 \pm 3.3$  mm and  $27.2 \pm 3$  mm. All these three values were higher than our combined mean of both right and left sides which was  $23.79 \pm 2.57$  mm. However Ozer *et al* (2006) [13] in the study on 94 male and 104 female scapulae, found that the mean AP-1 in male was  $27.33 \pm 2.4$  mm which was higher than present study but in female the mean AP-1 was  $22.72 \pm 1.72$  mm which was lower than our study (Table 4).

**Table 4:** Comparison of the anterior-posterior (AP-1) diameter by various studies

Observers	No of specimens	Mean SI Diameter A
Mallon <i>et al</i> (1992) <sup>8</sup>	28	24 ± 3.3 mm
Iannotti <i>et al</i> (1992) <sup>10</sup>	140	29 ± 3.2 mm
Von Schroeder <i>et al</i> (2001) <sup>11</sup>	30	28.6 ± 3.3 mm
Karelse <i>et al</i> (2007) <sup>9</sup>	40	27.2 ± 3. mm
Mamtha <i>et al</i> (2011) <sup>12</sup>	Right-98	23.35 ± 2.04 mm
	Left-104	23.02 ± 2.30 mm
Ozer <i>et al</i> (2006) <sup>13</sup>	Male -94	27.33 ± 2.4 mm
	Female -92	22.72 ± 1.72 mm
Present Study (2015)	Right-50	22.62 ± 2.06 mm
	Left-50	21.66 ± 2.08 mm

The mean anterior-posterior diameter (AP-2) of the upper half of the right glenoid was  $29.08 \pm 2.80$  mm and that of the left glenoid was  $28.09 \pm 2.60$  mm in the current study. The right glenoid cavity was slightly broader than the left glenoid cavity. The combined mean on both sides was  $28.90 \pm 2.58$  mm. This was much larger than what was observed by Iannotti *et al* (1992) [10], they found it to be  $23 \pm 2.7$  mm. Study conducted by Mamtha *et al* (2011)<sup>12</sup> found that mean AP-2 of the right glenoid was  $16.27 \pm 2.01$  mm and that of the left side was  $15.77 \pm 1.96$  mm, these values were smaller in the present study.

The various types of glenoid cavity depending on their shape observed in the present study were oval shaped on the right side 44 % while left side 46 %, pear shaped on right side 36% while left side 32% and inverted comma shaped on right side 20% while left side 22%.

The current findings indicate that the most common type of glenoid cavity is the oval shaped while the least one is the inverted coma shaped. These results match with others [7,14]. However, the current

results don't match with other reports [12,14].

Racial and sexual differences can interfere in the development of bone projections, providing alterations such as size and morphology. These alterations can occur in scapulae and may affect the glenohumeral stability. When the glenoid notch is distinct, the glenoid labrum is often not attached to the rim of the glenoid at the site of the notch and can be a predisposing factor in anterior dislocation of the shoulder joint [7].

## Conclusion

In the present study, the mean value of Superior-Inferior diameter (A) of the glenoid cavity on the right side was  $40.82 \pm 2.88$  mm and on the left side was  $39.49 \pm 2.72$  mm. The mean Anterior-Posterior glenoid diameter (B) was  $22.95 \pm 2.06$  mm on right side and  $21.66 \pm 2.08$  mm on left side. The mean Anterior-Posterior glenoid diameter (C) was  $29.08 \pm 2.80$  mm on right side and  $28.09 \pm 2.58$  mm on left side. The

shapes of glenoid cavities studied were oval [45%], pear shaped [34%] or inverted comma shaped [21%].

Variations in the size and shape of the glenoid cavity which were observed in the current study will be of great help for orthopedic surgeons to understand the shoulder pathology better and to decide the proper size of the glenoid component for the shoulder arthroplasty. Also it will be important for radiologists, anthropometrists, anatomists and other.

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### Conflict of Interest

nil

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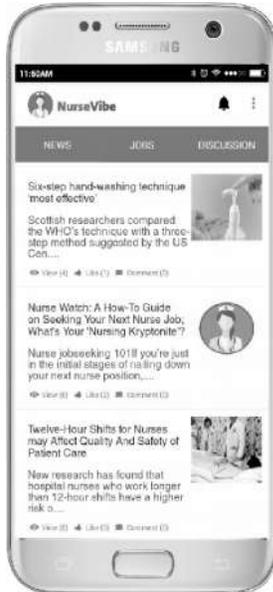
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## Morphological Study of Caecum with Its Arterial Supply in Adult Cadavers and Dead Fetuses

Surya Kumari N.\*, Usha C.\*, Srinivas C.H.\*\*

### Abstract

The caecum is involved in many surgical conditions such as carcinoma of caecum, lipoma of Caecum and volvulus of caecum. In spite of availability of modern diagnostic investigations, abdominal emergencies diagnosis mainly depends on clinical examination skills of the surgeon, who requires through knowledge of human anatomy; hence the present work is aimed to study the Caecum, its interior and arterial supply. *Material and methods:* Study includes 78 specimens, the dead fetuses (62) are obtained from labour rooms of the department of Obstetrics & Gynaecology, Government General Hospital and adult cadavers(16) are from dissection hall, Guntur medical college, Guntur. *Results:* Position of caecum in fetuses is mostly in the right lumbar region (70.96%) in some it is subhepatic, right iliac fossa and umbilical positions. In adults bodies it is in right iliac fossa 87.5%, and in 12.5% in the right lumbar region. Two fetuses showed Jackson's veil. In 9.67% of fetal specimens the anterior caecal artery is arising directly from the inferior division of ileo-colic artery and in 1.61% anterior caecal artery is directly arising from ileal artery. In 6.45% fetal specimens, posterior caecal artery is arising directly from inferior division of ileo-colic artery and in 3.22% it is arising directly from ileal artery. In 1.61% it is arising directly from colic artery. *Conclusion:* The present study of caecum showed variations from the literature available in position and arterial supply. These findings may help the surgeons in avoiding the complications while performing the abdominal surgeries.

**Keywords:** Caecum; Arterial Supply; Ileo-Caecal Junction.

### Introduction

A thorough knowledge about Anatomy of caecum and ileocaecal junction is essential for the surgeon who performs regular abdominal surgeries. Though there are advances in modern radiographic imaging and diagnostic laboratory investigations, the diagnosis of abdominal emergencies remains essentially clinical, requiring a mixture of observation, clinical acumen and surgical science [1,2].

The word caecum actually means blind in Latin, reflecting the fact that the bottom of the caecum is a blind pouch [a dead - end (or) cul- de- sac][3]. In order

to reach right iliac fossa the caecum and appendix undergoes 270° rotations. If they fail to rotate due to any mechanical obstruction in their course such as peritoneal adhesions or any other Mal-developments, the caecum and appendix may lie in the left iliac fossa, umbilical region, sub hepatic region or in the right lumbar region. Some times ileocaecal junction may lie in the right colic flexure if the ascending colon is congenitally absent. The Caecum acts as a guide in the operation of intestinal obstruction. If the Caecum is distended, the obstruction occurs in large gut; if it is empty it indicates that the obstruction is of small gut [2,4-8].

The caecum is supplied by the branches of ileocolic artery which is in turn a branch of superior mesenteric artery. Hence the variations and anomalies pertaining to these vessels having greater importance while studying the caecum and ileocaecal junction. Considering the significance of anatomy in the field of modern surgery, we made an attempt to study in detail about morphology of Caecum and its arterial supply.

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## Materials and Methods

The present work is aimed to study the Caecum with arterial supply. The material of our study includes 78 specimens, out of which 62 are dead fetuses of both sexes and 16 are adult cadavers (male & female). The dead fetuses are obtained freshly from labour rooms of the department of Obstetrics & Gynecology, Government General hospital, Guntur. The adult cadavers included in our study are from dissection hall in the department of Anatomy, Guntur medical college, Guntur.

The age of the fetuses is determined by measuring crown-rump length. The features such as development of nails, subcutaneous tissue, and distribution of hair and vernix-caseosa are taken into consideration to determine the age if crown-lump length of the fetuses is less. All the fetal specimens are preserved as per the standard methods.

### Mode of Dissection

An incision is made vertically extending from xiphisternum to pubic symphysis and abdomen is opened. The greater omentum is cut; the coils of small intestine, transverse colon and transverse mesocolon are mobilized towards the upper abdomen to visualize the ileocaecal junction and vermiform appendix. The position and shape of the caecum are noted with its peritoneal and general relations. The length and breadth of the caecum are measured. The entry of terminal part of ileum into the caecum is noted. The mesentery is cleaned, ileocolic artery branches are traced and their variations are noted. The caecum is opened as per the dissection guidelines of Russell T. Woodburne, by giving a window incision on its anterior wall. The ileocaecal and appendicular orifices are identified. The distance between the two orifices is measured. Their position, shape and diameter are noted. The measurements of superior and inferior labia, medial and lateral frenulae are taken.

### Observations

#### Position of the Caecum

out of 62 foetuses in 44 (70.96%) the Caecum is found in the right lumbar region. In 12 (19.35%) - sub-hepatic region, 5 (8.06%) - right iliac fossa and Umbilical position is seen only one foetal specimen (1.6%), Whereas in adult specimens 14 (87.5%) it was in the right iliac fossa. In 2 (12.5%) it was found in the right lumbar region (Figure 1).



**Fig. 1:** Adult specimen showing: Asymmetrical shaped caecum in the *right lumbar region*, entry of ileum in to the caecum from postero-medial aspect, and ileo-colic artery with normal arterial distribution. (C- caecum, I.C.A- Ileo-colic artery)

#### Shape of the Caecum

Conical shape in 56 (90.32%), Quadrate in 4 (6.45%), Asymmetrical in 2 (3.22%) of the fetal specimens, whereas it was Asymmetrical in shape in all 16 adult specimens (100%).

When the peritoneal reflections over the Caecum were observed all 16 adult specimens and in 60 (96.77%) fetal specimens it is completely covered by the peritoneum and was freely mobile in the abdominal cavity. But when it comes to 2 fetal specimens (3.22%) the upper part of posterior surface of the Caecum is non peritoneal and comes in contact with fascia illiaca that is in-complete. We also found Jackson's veil in 2 fetuses (3.22%) (Figure 2).



**Fig. 2:** Fetal specimen showing: Conical shape caecum in the *right lumbar region* and upper part of caecum showing Jackson's veil. (C- Caecum, J.M- Jackson's Membrane or veil)

#### Entry of Ileum into the Caecum

In 64.51% that is 40 fetuses the entry of ilum in to the Caecum is from posteromedial aspect, in 29.03% (18) from ileal aspect, 4.83% (3) antero-medial aspect

as in adult bodies posterior-medial entry is seen in 75% (12 bodies). Medial and antero-medial entry was found in 2 bodies each (12.5% and 12.5%).

The length and breadth of Caecum: (Table 1)

Interior of the Caecum:-

- Position of ileocaecal orifices – (Tables 2)
- Shape of ileocaecal orifice- (Table 3)
- Diameter of ileocaecal orifice- (Table 4)
- Position, diameter of Appendicular orifice and distance between Appendicular and ileocaecal orifice- (Table 5).

Appendicular orifice is guarded by semicircular mucus fold known as valve of Gerlach. It is not seen in fetal specimens but it was found in all adult specimens. This valve is attached to the lower margin in 10 adult specimens, whereas in 6 adult specimens it was attached to the upper margin.

*Arterial Supply*

The course of ileocolic artery is varied according to the position of the caecum & appendix.

Origin of the ileocolic artery- (Table 6)

Origin of caecal artery: (Table 7)

**Table 1:** The length and breadth of Caecum

specimen	Average Length In mm.	Average Breadth In mm.
Fetal specimens N=62	7.69	9.43
Adult specimens N=16	61.25	70.83

**Table 2:** Position of the ileo-caecal orifice

Specimen	Postero-medial wall of the Caecum	Medial wall of the Caecum	Antero -medial wall of the Caecum
Fetal specimens (n=62)	64.51%	29.03%	6.45%
Adult specimens (n=16)	75%	12.5%	12.5%

**Table 3:** Shape of the ileocaecal orifice in adults

Specimen	Oval		Circular
	Horizontal	Oblique	
Fetal specimen (n = 62)	3.22 %	12.9 %	83.87 %
Adult specimens (n = 16)	100 %	-	-

**Table 4:** The diameter of the ileocaecal orifice in adults

Specimen	Circular	oval	
		Average Long diameter In mm	Average Short diameter In mm
Fetal specimens (n=62)	2.75	5.2	2.25
Adult specimens (n=16)	-	17.25	7.12

**Table 5:** The position & diameter of Appendicular orifice & the distance between appendicular and ileocaecal orifices

specimen	Posteromedial wall of Caecum	Position Medial wall of Caecum	Dependent part between two saccules	Circular Appendicular orifice diameter In mm	Distance between Appendicular orifice & ileocaecal orifice In mm
Fetal specimens n=62	85.24%	11.47%	3.27%	1.83	4.77
Adult specimens n=16	50%	37.5%	12.5%	8.37	25

**Table 6:** Origin of the ileocolic artery

specimen	Right side	From superior mesenteric artery		Common with right colic artery
		Left side	Anterior surface	
Fetal specimens n=62	95.16%	-	1.61%	3.22%
Adult specimens n=16	87.5%	12.5%		

**Table 7:** Origin of caecal artery:

specimen	From inferior division of ileo-colic artery	Absent, where anterior and posterior caecal arteries arising separately
Adult cadavers N-16	100%	-
Fetuses N-62	88.7%	11.29%

### Course of Caecal Artery

In 55(88.7%) fetuses and all 16 adult specimens the caecal artery arising from the inferior division of ileocolic artery, is passing towards the ileocaecal junction and a little above the level of the upper border of the ileocaecal junction it is divided into an anterior and posterior caecal branches which supply the corresponding surfaces of the caecum.

### Origin of the Anterior Caecal Artery

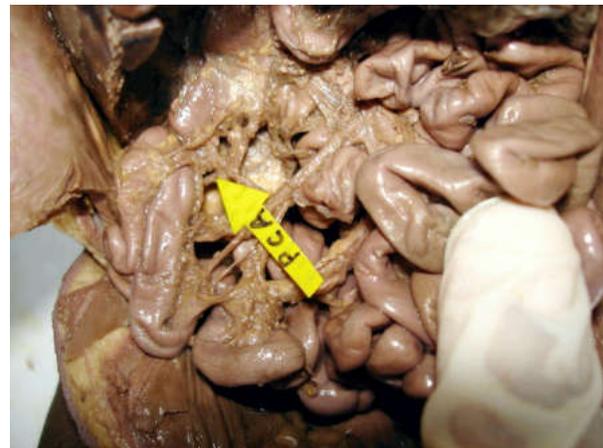
In 55(88.5%) foetal specimens and all 16 adult specimens the anterior Caecal artery is arising in common with posterior caecal artery from caecal artery which in turn arising from inferior division of ileocolic artery. In 6 (9.67%) foetal specimens the anterior caecal artery is arising directly from inferior division of ileocolic artery. In one foetal specimen (1.61%) anterior caecal artery is arising directly from ileal artery which in turn a branch of inferior division of ileocolic artery. In one adult specimen the caecum is receiving an additional branch from the colic artery.

### Origin of Posterior Caecal Artery

In 55(88.7%) foetal specimens and all 16 adult Specimens it is arising in common with anterior caecal artery from caecal artery which in turn is a branch from inferior division of ileocolic artery. In 4(6.45%) foetal specimens the posterior caecal artery



**Fig. 3:** Fetal specimen showing: Anterior caecal artery independently arising from inferior division of ileo-colic artery, and posterior caecal artery arising from ileal artery. (A.C.A- Anterior Caecal Artery, P.C.A- Posterior Caecal Artery)



**Fig. 4:** Fetal specimen showing: Posterior caecal artery arising from colic artery and anterior caecal artery directly from inferior division of ileo-colic artery. (P.C.A- Posterior Caecal Artery)

is arising directly from inferior division of ileocolic artery. In 2(3.22%) posterior caecal artery is arising directly from ileal artery which in turn a branch of inferior division of ileocolic artery. In one (1.61%, fetus), the posterior caecal artery is arising directly from colic artery which in turn a branch of superior division of ileocolic artery. (Figure 3 and Figure 4).

## Discussion

### Position of the Caecum

In 14 (87.5%) out of 16 adult cadavers the caecum is in the right iliac fossa, where as in two (12.5%) it is in the right lumbar region and this study is in agreement with the descriptions of many standard text books and recent researchers (Table 8). In 44(70.96%) foetal specimens with crown rump length ranging from 170mm-340 mm, the caecum is situated in the right lumbar region and in 12(19.35%) fetuses with C R length ranging from 200mm - 350mm, it is situated in the sub-hepatic position. In 5(8.06%) fetuses with CR length ranging from 220mm- 365mm, it is situated in the right iliac fossa. In one (1.61%) fetus with a CR length of 290mm, it is situated in the umbilical position (Table 9). According to Datta [6] and Treves' [13] the variation in the position of the caecum may be due to the failure of the rotation of the embryonic intestinal loop or its incomplete rotation.

Position of Caecum in adult specimens (Table 8).

Position of Caecum in foetal specimens (Table 9).

*Shape of the Caecum*

In all 16 (100 %) adult bodies it is asymmetrical, which is nearly coinciding with the descriptions of the standard text books.

*Shape of the Caecum in fetuses*

Table 10

*Peritoneal reflections of the Caecum*

Out of 62 foetuses in 60 (96.77 %) it is complete, and in 2(3.22%) foetuses it is incomplete. In all 16(100%) adult specimens, the caecum is completely covered by peritoneum and is freely mobile in the abdominal cavity which is coinciding with the literature.

Jackson’s membrane is anomalous peritoneal fold containing fine blood vessels may pass from the front

of the ascending colon and caecum to the lateral part of the posterior abdominal wall. It may be continuous on the left with the greater omentum. In these cases the caecum is fixed. This thin sheet of peritoneum is called Jackson’s veil [7,16]. Henry Hollinshed [8] described it as a broad, highly vascular membrane usually attaching to the whole length of the ascending colon but not the caecum. Gray [7] and Cunningham [16] described pericolic bands reduce the normal mobility of colon. Jackson’s membrane is generally considered to be arising as a result of adhesions of peritoneum in fetuses. It may be due to normal sequence of shifting relations of ascending colon and might be due to the result of hyper rotation of the colon.

In the present study, Jackson’s veil is found in 2 (3.22%) fetuses. It is appeared as a thick sheet of peritoneum extending from front of the upper part of the caecum and proximal part of the ascending colon to the lateral part of the posterior abdominal wall. This pericolic band is not seen in the 16 adult specimens dissected.

**Table 8:** Position of Caecum in adult specimens

Name of the author	Right iliac fossa	Right lumbar	Sub-hepatic	Umbilical
S.N.Sahana [9]	Common	Few	Few	-
Kavimani. M [3]	96%	-	4%	-
Umamaheswar rao.S [10]	100%	-	-	-
W.J.Hamilton [11]	Common	Rare	-	Rare
Gray [7]	Common	-	-	-
Datta [6]	Common	Rare	-	-
Arindom Benerjee [12]	96%	-	4%	-
Present study	87.5 %	12.5 %	-	-

**Table 9:** Position of Caecum in foetal specimens

Name of the author	Right Lumbar	Sub-hepatic	Right Iliac fossa	Umbilical
Treves [13]	common	common	-	-
Janardhan Rao.M [14]	60%	10%	30%	-
Morris [15]	-	-	-	Rare
Present study	70.96 %	19.35 %	8.06 %	1.61 %

**Table 10:** Shape of the caecum in fetuses

Name of the author	Conical	Quadrate	Asymmetrical
S. N. Sahana [9]	Common	-	-
Treves [13]	Common	-	-
Morris [15]	Common	Few	-
Present study	90.32 %	6.45 %	3.22 %

*Entry of Ileum into the Caecum*

In 40 (64.5%) fetuses and in 6(75%) of adult specimens, the entry of ileum into the caecum is from posteromedial aspect. In 18 (29.03%) fetuses and in one (12.5%) adult specimen the entry is from medial aspect. In 3 (4.83 %) fetuses and in one (12.5%) adult specimen it is from anteromedial aspect. In one

(1.61%) fetus, the ileum is entering the caecum from the anterior aspect. Normally the ileum enters the caecum posteromedially, sometimes medially and occasionally from the posterior aspect [6,15]. But Datta[6] and Hamilton [11] stated that the ileal entry will be usually from the medial side. Whereas Sahana [9] and Inderbir singh [17] stated that ileum enters

the caecum from postero medial aspect.

#### *Measurements of the Caecum*

According to Cunningham[16] and Quain [5] its length is 60mm and the breadth is 70mm. In the present study of the adult specimens, the average length is 61.25mm and the breadth is 70.83mm, which are in consistence with the descriptions of most of the standard text books [9,17]. In fetuses [62] the average length of the caecum is 7.69mm and the breadth is 9.44mm. In the present study, it is observed that the average breadth of the caecum is more than that of length of the caecum in both adult and foetal specimens.

#### *General Relations of the Caecum*

The relations of the caecum vary depending on the position of the caecum in the abdominal cavity. The relations of the caecum observed in the present study are correlating with the descriptions of the standard text books [7, 16].

#### *Position of the Ileocaecal Orifice*

In 40 (64.51%) foetal and 12(75%) adult specimens, the ileocaecal orifice is situated in the posteromedial aspect of the wall of the caecum. These observations are in agreement with descriptions of Datta [6], Gray [7].

In 18 (29.03%) foetuses and in two (12.5%) adult specimen it is situated in the medial aspect of the wall of the caecum. These observations are coinciding with the descriptions of Gray [7]. In 4 (6.45%) fetuses and one (12.5%) adult specimen it is situated in the anteromedial aspect of the wall of the caecum which is correlating with the description of Morris [15].

#### *Shape of the Ileocaecal Orifice*

In 52(83.87%) fetal specimens it is circular and it is oval in 10(16.12%) fetuses and in 16(100%) adult specimens. This is consistent with the statement of Cunningham[16]. The change in the shape of the ileocaecal orifice from circular in the fetuses to oval in adults may be due to functional adaptation to the changed food habits like, from fluid diet to solid diet and also asymmetrical growth of the saccules of the caecum as age advances.

#### *Labia*

In 62 fetuses, the average length of the superior labium is 2.06mm and the average length of the inferior labium is 3.06mm. The average length of the

superior labium in all adults is 19.75mm and that of the inferior labium is 23.87mm. Thus, the superior labium is shorter than inferior labium in both fetuses and adults, which are in consistence with the descriptions of Henry Hollinshed [8].

#### *Frenulae*

in 9 fetal specimens the medial frenulum is absent (Figure 5), in 5 both medial and lateral frenulae are absent. In 4 adult cadavers the medial frenulum is absent and in the rest the average length of the medial frenulum is 19 mm, and that of the lateral frenulum is 21.12mm. By these observations it is clear that lateral frenulum is longer than the medial frenulum. According to Buirge (quoted by Henry Hollinshed [8]) the medial or lateral or both the frenulae may be absent. These findings are in agreement with the Buirge's descriptions.



Fig. 5: Fetal specimen showing: Medial frenulum absent and presence of left frenulum. (L.F- Left Frenulum)

#### *Appendicular Orifice*

In 52(85.24%) fetuses and in 8(50%) adult specimens it is present in the posteromedial aspect of the wall of the caecum. The present study is correlating with the standard literature [16]. In 7(11.47%) fetuses and 6 (37.5%) adult specimens showed the appendicular orifice in the medial aspect of the wall of the Caecum. Whereas in 2(3.27%) fetuses and 2(12.5%) adult specimen, it is in the dependent part between two saccules of the caecum and this is in consistent with the description of Hamilton[11]. When it comes to shape both fetus and adult specimens it is circular, which is similar to the descriptions of standard text books [15,16].

#### *Diameter of the Appendicular Orifice*

In 61 fetuses (appendix is absent in one fetal specimen), the average diameter of appendicular

orifice is 1.83mm where as in 16 adult specimens it is 8.37mm. This study is coinciding with the descriptions of Quain [5].

*Distance between Appendicular Orifice and Ileocaecal Orifice*

In 61 fetal specimens, the average distance between two orifices is 4.77mm. In the adult specimens, the distance between two orifices is 25mm and this value is coinciding with the descriptions of Morris [15] and Cunningham [16].

*Valve of Gerlach* Is not seen in any of the fetal specimens studied, but it is found in all the adult

specimens. In 10 adult specimens, it is found attached to the lower margin of the orifice. This finding is coinciding with the statement of Datta [6]. In 6 adult specimens, it is attached to the upper margin of the orifice and this is in agreement with the description of Quain [5].

*Arterial Supply of the Caecum*

Origin of the ileo-colic artery in adult & fetal specimens (Table11).

Origin of caecal artery in adult and fetal specimens (Table 12).

**Table 11:** Origin of the ileo-colic artery in adults & foetuses

Name of the author	Independently From superior mesenteric artery			Common with right colic artery
	Right side Of S.M.A	Anterior surface Of S.M.A	Left side Of S.M.A	
Gray [7]	Present	-	-	present
W. Henry Hollinshed [8]	Present	-	-	Present
S. N. Sahana [9]	Present	-	-	-
Present study	Adults 87.5%	-	12.5%	-
	Foetuses 95.16%	1.61 %	-	3.22 %

**Table 12:** Origin of caecal artery in adults and fetuses

Name of the author	From inferior division of ileo-colic artery	Absent, where anterior and posterior caecal arteries arising separately
Gray [7]	Present	-
W. Henry Hollinshed[8]	Present	-
Morris [15]	Present	-
Present study	Adults 100 %	-
	Foetuses 88.7 %	11.29 %

*Origin of the Anterior and Posterior Caecal Arteries*

In 55(88.7%) fetuses and 100% of the adult specimens both anterior and posterior caecal arteries are arising from inferior division of ileocolic artery. This finding is similar to that of Gray[7]and Morris[15]. In 6(9.67%) foetuses, the anterior caecal artery is arising separately from the inferior division of ileocolic artery. In 4(6.45%) Foetuses, the posterior caecal artery arising separately from the inferior division of ileocolic artery, and these findings are in agreement with the description of Henry Hollinshed [8].

In one (1.61%) foetus, the anterior caecal artery is arising separately from the ileal artery. In 2(3.22%) foetuses, posterior caecal artery is arising separately from ileal artery. In one (1.61%) foetus, posterior caecal artery is arising separately from colic artery. And comparison of this pattern cannot be made because no literature is available.

**Conclusion**

The present detailed study of caecum with its arterial supply in 62 dead fetuses and 16 adult cadavers showed variations in structure when compared to standard books; like position of caecum in the foetuses, these alterations can be attributed to the embryological basis of gut rotation. Adult and fetal specimens showed variation in the branching patterns in the arterial supply of the Caecum. These findings may be of help to the surgeon while performing the surgeries and prevent the complications.

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## Morphometric Analysis of Dry Adult Human Mandibular Ramus

Deepa G.\*, Shrikrishna B.H.\*\*

### Abstract

*Background and Objective:* The knowledge of morphometric analysis of the ramus of mandible helps in forensic analysis as well as in several maxilla-facial surgeries. Many studies on linear and angular morphometry of the mandibular body have been conducted, but those on the mandibular ramus have not yet been reported. Our study aimed at doing Morphometric analysis of mandibular ramus. *Materials and Methods:* Fifty dry adult human mandibles were collected from the collection of the department of Anatomy of Navodaya Medical College, Raichur. The Morphometric analysis of the mandibles was done with vernier calipers. *Results:* The mandibular ramus was at the same distance from each landmark on both sides demonstrating symmetry. There was no significant difference in the values on the right and left sides of the mandibles. *Conclusion:* Anatomic knowledge of the morphometry of the ramus of mandible helps us in solving forensic problems as well as in maxilla-facial surgeries.

**Keywords:** Mandible; Mandibular Condyle; Human; Anatomy; Population.

### Introduction

Mandible is the largest, strongest and lowest bone in the face and best preserved part of the body after death along with maxilla and teeth [1]. If we consider skull for sex determination, mandible may play a vital role, as it is the most dimorphic bone of skull [2]. Mandible is an important tool in the determination of gender with high accuracy [3]. Human mandibular morphology is often thought to reflect mainly function, and to be of lesser value in studies of population history. Previous descriptions of human mandibles showed variation in ramal height and breadth to be the strongest difference among recent human groups. Mandible is the largest, strongest and movable part of the skull [4]. They are extremely durable in fire and bacterial decomposition makes them invaluable for identification [5]. The mandibular ramus is quadrilateral, and has two surfaces, four borders and two processes. The lateral surface is relatively

featureless [6]. The anterior part of ramus is thin above but the posterior is thick and rounded and can be used as the donor site for reconstruction of small bone defects in the oral and maxillofacial region [7,8]. The mandibular ramus suffers morphological alteration associated with tooth losses [9,10]. Many studies on linear and angular morphometry of the mandibular body have been conducted, but despite the significance of mandibular ramus, studies on the mandibular ramus have not yet been reported. Our study aimed at doing Morphometric analysis of mandibular ramus.

### Materials and Methods

Our study group included 50 dry adult human mandibles with complete dentition with intact alveolar margin and intact ramus and of unknown sex which were collected from the department of Anatomy of Navodaya Medical College, Raichur of Karnataka state. Pathological, fractured, deformed and developmental disturbances of the mandible were excluded from the study. Vernier calipers was used to measure the linear measurements of following parameters: 1. from the base of mandible to the highest point of the head of mandible (Figure 1). 2. from the base of mandible to the mandibular notch (Figure 2)

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and 3. the maximum breadth of ramus from anterior edge of ramus to posterior edge of ramus at the occlusal plane (Figure 3). The two authors recorded the above measurements independently and a mean of the two recordings was taken for final statistics. Measurements were recorded to the nearest millimetre. After each parameter was measured, calculated, and assessed, the mean value and standard deviation were computed using Microsoft Excel of Microsoft Office 2000. The paired "t" test was used to compare the mean values of right and left sides of the mandible. p-value <0.05 was considered statistically significant.

### Results and Observations

In our study we noted that the mean measurement from the base of mandible to the highest point of the head of mandible was  $64.2 \pm 6.6$  mm on the right side

and  $64.3 \pm 7.1$  mm on the left side. The minimum and maximum values on the right side were 52 mm and 77 mm respectively. The minimum and maximum values on the left side were 51 mm and 79 mm respectively. The mean measurement from base of the mandible to the mandibular notch was  $39.5 \pm 9.2$  mm on the right side and  $40.2 \pm 9.0$  mm on the left side. The minimum and maximum values on the right side were 27 mm and 59 mm respectively. The minimum and maximum values on the left side were 26 mm and 62 mm respectively. The mean measurement from the anterior edge to the posterior edge of ramus corresponding to its width was  $29.4 \pm 4.6$  mm on the right side and  $29.5 \pm 4.8$  mm on the left side. The minimum and maximum values on the right side were 21 mm and 37 mm respectively. The minimum and maximum values on the left side were 18 mm and 38 mm respectively (Table 1). On statistical analysis, it was found that there was no significant difference in the values on the right and left sides of the mandible.

**Table 1:** Morphometry of mandibular ramus (ns= Not Significant)

Sl. No	Variables	Right Side (mm) MEAN± SD (n=50)	Left Side (mm) MEAN± SD (n=50)	p VALUE
1	Distance from the base of mandible to the head of mandible	$64.2 \pm 6.6$	$64.3 \pm 7.1$	0.47 (ns)
2	Distance from base of the mandible to the Mandibular notch	$39.5 \pm 9.2$	$40.2 \pm 9.0$	0.47 (ns)
3	Distance from the anterior edge to the posterior edge of RAMUS	$29.4 \pm 4.6$	$29.5 \pm 4.8$	0.17 (ns)



**Fig. 1:** Measurement of the distance from the base of mandible to the head of mandible using vernier calipers



**Fig. 2:** Measurement of the distance from base of the mandible to the mandibular notch using vernier calipers



**Fig. 3:** Measurement of the distance from the anterior edge to the posterior edge of ramus at the occlusal plane using vernier calipers

### Discussion

The morphology of the human mandible is often thought to be of only functional significance. However, it is also important in studying the population history, sexual dimorphism as well as its role in maxilla-facial surgeries. Previous descriptions

of human mandibles showed variation in ramal height and breadth to be the strongest difference among recent human groups. Several mandibular traits that differentiate Neanderthals from modern humans include greater robusticity, a receding symphysis, a large retro-molar space, a rounder gonial area, an asymmetric mandibular notch, and a posteriorly positioned mental foramen in Neanderthals [11].

Analyses of human mandibular form addressed the temporal trend toward gracilization observed in modern humans [12,13,14]; evaluated the usefulness of the mandible in classifying human groups [15,16]; assessed patterns of sexual dimorphism [16-21] and functional aspects of mandibular morphology [22]; and described differences between modern and fossil forms [23-25]. Traits found to differ among recent human populations include ramal height and breadth, ramal obliqueness, corpus robusticity, mandibular (sigmoid) notch shape, bi-condylar breadth, and mental foramen position [22,26]. However, in some cases, these differences are thought to be related to masticatory behaviour and adaptation [22,27]. In the earlier studies, it has been found out that males and females differ most markedly in the height of the symphysis and of the ramus, and differences are more pronounced in the ramus than in the body of the mandible [18,19,27]. The study on the mandibles of Arctic populations has described them as large and robust, with a short, broad, and oblique vertical ramus; a low and robust coronoid, resulting in a shallow mandibular notch. The same study also revealed the Arctic mean configuration with a low coronoid process, an antero-posteriorly broad ascending ramus [11]. This type of wide ramus is thought to increase the moment arm of the temporalis and masseter muscles, while the low position of the coronoid process results in a more vertical orientation of the temporalis. Previous studies have found a reduction in the ramus width and in the anterior length of the mandible and the face from *H. Heidelbergensis* to Neanderthals [24,28].

Studies by Loth & Henneberg describe a flexure in the posterior margin of the ramus that was present in male, but absent in female mandibles, and that the ramus flexure is useful in sex determination. They claimed sexing accuracy ranging from 90.6% to 99% that the ramus is flexed in males at the occlusal plane whereas in females it is either straight or flexed near the neck of condyle process or in association with gonial prominence [29, 30, 31]. On the other hand, the studies by Donnelly et al. and Haun report about poor association between ramus flexure and sex determination [32,33]. Some studies have reported

that the method of using ramus flexure as a tool to study sexual dimorphism is of more diagnostic sensitivity to females [34,35]. The controversy among researchers regarding the predictive accuracy of ramus flexure method has, obviously, resulted from differences in the nature of the samples employed by different investigators. In our study, we have not analysed the sexual dimorphism of the mandibular ramus.

The changes in the shape of the mandible is affected by the forces of muscles, particularly the elevator muscles, which is determinant in the modelling of the mandibular ramus. These forces are at their peak in young adults [36]. This is the time around which the growth at the temporo-mandibular joint ceases. Prior to that age and throughout the period of active growth, the expression of the shape of mandible including ramus flexure is in response to hormonal influences and is governed, in both sexes, by the forces exerted by the masticatory muscles. Thus, the observed variations in mandibular ramus morphology have a biomechanical rather than hormonal origin [36].

In males, where rugosity of the medial pterygoid muscles attachment is noticeably more pronounced than that of the masseter, the ramus appears much more vertical. The temporalis and the lateral pterygoid muscles attach well above the flexure [29]. The influence of muscles in moulding the mandibular ramus is expected to come to a complete halt at the cessation of growth at the temporo mandibular joint around the age of young adulthood. Further musculoskeletal maturation at older ages is not expected to incur any significant change in the shape of females, but the mandible in both sexes retain its pubertal shape in older ages [37]. Researchers have attributed the differences in their findings to population specific factors influenced by environmental functional variables such as chewing habits and food type [37].

In our study, the mean measurement from the base of mandible to the highest point of the head of mandible was  $64.2 \pm 6.6$  mm on the right side and  $64.3 \pm 7.1$  mm on the left side. The present finding is consistent with Rai et al [38] and Mesbahul Hoque et al [39] but differed from Saini et al. [40] and Rosa et al. [41].

In our study, the mean measurement from base of the mandible to the mandibular notch was  $39.5 \pm 9.2$  mm on the right side and  $40.2 \pm 9.0$  mm on the left side. This finding of the present study is consistent with Keros et al. [42] but differed from Jerolimov et al. [43] and Mesbahul Hoque et al [39].

In our study, the mean measurement from the

anterior edge to the posterior edge of ramus corresponding to its width was  $29.4 \pm 4.6$  mm on the right side and  $29.5 \pm 4.8$  mm on the left side. This finding of the present study is consistent with Keros et al. [43], Jerolimov et al. [43], Oguz and Bozkir [44], Kilarkaje et al. [45] Ennes and Medeiros [46] and Mesbahul Hoque et al [39].

### Conclusion

Our study concludes that the mean measurement from the base of mandible to the highest point of the head of mandible was  $64.2 \pm 6.6$  mm on the right side and  $64.3 \pm 7.1$  mm on the left side. The mean measurement from base of the mandible to the mandibular notch was  $39.5 \pm 9.2$  mm on the right side and  $40.2 \pm 9.0$  mm on the left side. The mean measurement from the anterior edge to the posterior edge of ramus corresponding to its width was  $29.4 \pm 4.6$  mm on the right side and  $29.5 \pm 4.8$  mm on the left side. There was no significant difference in the values on the right and left sides of the mandible which depicts that mandible maintains bilateral symmetry. Anatomic knowledge of the morphometry of the ramus of mandible helps us in solving forensic problems, in anthropological assessments as well as in maxilla-facial surgeries.

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2 Gastroenterology International	2	5500	5000	550	500
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4 Indian Journal of Anatomy	3	8000	7500	800	750
5 Indian Journal of Ancient Medicine and Yoga	4	7500	7000	750	700
6 Indian Journal of Anesthesia and Analgesia	3	7000	6500	700	650
7 Indian Journal of Biology	2	5000	3500	400	350
8 Indian Journal of Cancer Education and Research	2	8500	8000	850	800
9 Indian Journal of Communicable Diseases	2	8000	7500	800	750
10 Indian Journal of Dental Education	4	5000	4000	450	400
11 Indian Journal of Forensic Medicine and Pathology	4	15500	15000	1550	1500
12 Indian Journal of Forensic Odontology	2	5000	4000	450	400
13 Indian Journal of Genetics and Molecular Research	2	6500	6000	650	600
14 Indian Journal of Law and Human Behavior	2	5500	5000	550	500
15 Indian Journal of Library and Information Science	3	9000	8500	900	850
16 Indian Journal of Maternal-Fetal & Neonatal Medicine	2	9000	8500	900	850
17 Indian Journal of Medical & Health Sciences	2	6500	6000	650	600
18 Indian Journal of Obstetrics and Gynecology	3	9000	6500	700	650
19 Indian Journal of Pathology: Research and Practice	3	11500	11000	1150	1100
20 Indian Journal of Plant and Soil	2	5500	5000	550	500
21 Indian Journal of Preventive Medicine	2	6500	6000	650	600
22 Indian Journal of Research in Anthropology	2	12000	11500	1200	1150
23 International Journal of Food, Nutrition & Dietetics	3	5000	4500	500	450
24 International Journal of History	2	6500	6000	650	600
25 International Journal of Neurology and Neurosurgery	2	10000	9500	1000	950
26 International Journal of Political Science	2	5500	5000	550	500
27 International Journal of Practical Nursing	3	5000	4500	500	450
28 International Physiology	2	7000	6500	700	650
29 Journal of Animal Feed Science and Technology	2	4100	3600	410	360
30 Journal of Cardiovascular Medicine and Surgery	2	10000	8600	910	860
31 Journal of Forensic Chemistry and Toxicology	2	9000	8500	900	850
32 Journal of Microbiology and Related Research	2	8000	7500	800	750
33 Journal of Orthopaedic Education	2	5000	4500	500	450
34 Journal of Pharmaceutical and Medicinal Chemistry	2	16000	15500	1600	1550
36 Journal of Social Welfare and Management	3	7500	7000	750	700
37 Meat Science International	2	5000	4500	500	450
38 New Indian Journal of Surgery	3	7500	6600	710	660
39 Ophthalmology and Allied Sciences	2	5500	5000	550	500
40 Otolaryngology International	2	5000	4500	500	450
41 Pediatric Education and Research	3	7000	6500	700	650
42 Physiotherapy and Occupational Therapy Journal	4	8500	8000	850	800
43 Urology, Nephrology and Andrology International	2	7000	6500	700	650
44 Indian Journal of Emergency Medicine	2	12000	11500	1200	1150
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## A Study of Morphology of Psoas Minor Muscle in Human Cadavers

Shilpa Bhimalli\*, Daksha Dixit\*\*, S.P. Desai\*\*\*, Amit Magdum\*\*\*\*, Sheetal Pattanshetti\*\*\*\*

### Abstract

The Psoas Minor is a slender Muscle lying on the surface of Psoas Major Muscle. It is functionally a weak muscle that assists Psoas major in flexion of the trunk and vertebral column. The muscle normally arises from the sides of the bodies of twelfth thoracic vertebra and first lumbar vertebra with corresponding intervertebral disc. *Materials and Method:* The study is conducted on 30 cadavers from the Department of Anatomy J.N. Medical College Belagavi. The Psoas minor muscle was observed from its origin to its insertion. Length and width of the muscle, its fleshy belly and tendon part of the muscle was measured and the observations were tabulated. The normal anatomy and variations of the muscle were noted. *Results:* In the present study it was observed that the Psoas minor was present in 60% (18/30 cadavers) and absent in 40% (12/30 cadavers). It was observed that the muscle was bilaterally seen in 18 cadavers, and 12 cadavers showed unilateral presence. *Conclusion:* In the present study, conducted on 30 cadavers, the Psoas minor muscle was observed in 60% of cadavers. It was bilaterally seen in 7 cadavers and unilaterally seen in 5 cadavers. The normal anatomy and variations were noted. In any lower spine surgeries, the normal and variant anatomy of the muscle is important to note, and if neglected can lead to any complications during the surgery.

**Keywords:** Fleshy & Tendinous Part; Psoas Minor Muscle; Unilateral Muscle.

### Introduction

The Psoas Minor is a slender Muscle lying on the surface of Psoas Major Muscle. It is functionally a weak muscle that assists Psoas major in flexion of the trunk and vertebral column. The muscle normally arises from the sides of the bodies of twelfth thoracic vertebra and first lumbar vertebra with corresponding intervertebral disc. The origin of the muscle varies from thin slender to broad and thick belly. The muscle is normally inserted to the pectineal line of pubis and iliopectinate eminence. The insertion of the muscle varies with formation of thin long tendon inserting to bony attachment or merging with the fascia. Psoas

minor receives its nerve supply from the ventral rami of L1 spinal nerve. The Psoas minor muscle is well developed in lower animals that run very fast. While in humans it has clinical significance in sport person, more commonly affected are the foot ball players [1]. It is muscle that has highest percentage of unilateral or bilateral agenesis between 40% and 66% of the population [2]. The study is aimed to obtain a detailed knowledge of morphometry of Psoas minor muscle.

### Materials and Method

The study is conducted on 30 cadavers from the Department of Anatomy J.N. Medical College Belagavi. The posterior abdominal wall muscles were exposed and then the Psoas minor muscle was noted. The Psoas minor muscle was observed from its origin to its insertion. Length and width of the muscle, its fleshy belly and tendon part of the muscle was measured and the observations were tabulated. The normal anatomy and variations of the muscle were noted.

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## Results

In the present study it was observed that the Psoas minor was present in 60% (18/30 cadavers) and absent in 40% (12/30 cadavers). It was observed that the muscle was bilaterally seen in 7 cadavers, and 5 cadavers showed unilateral presence. The muscle belly originated normally in all the cadavers. The average length of the fleshy belly was 7.5cm and width was 1.91cm. (Table 1).

Tendon, in all cadavers was long, slender and

**Table 1:** The length and width of the fleshy belly of the Psoas minor muscle

S. No	Length of fleshy belly(cm)	Width of fleshy belly(cm)
1	7.5	2
2	7	1.5
3	5.5	2.5
4	4.5	2
5	9	2
6	7	2.5
7	7.5	1
8	6.5	1.7
9	8	2
10	7.5	2
11	7	2.5
12	7	2
13	8	2
14	7.5	1.5
15	6.5	1.5
16	7.5	1.5
17	7	2
18	7	2
19	8	1.8
20	8.5	1.5
21	7.5	2
22	7	2
23	7	2.5
24	8	1.5
25	8	1.2
26	7.5	1.5
27	9.5	2
28	7	2.5
29	7	1.5
30	6.5	1.5

flattened. The average length of the tendon was 11.17cm and width was 0.7cm (Table 2).

The tendon flattened towards the insertion. Variations were observed in the morphology of the muscle. In one cadaver it was seen that the muscle had a fleshy origin, was very short and broad, and had a long slender tendon (Figure 1).

In another cadaver it was observed that the muscle had a normal origin, but the tendon was slender and long, and merged with iliopsoas fascia. The muscle received the nerve supply from L1 from Lumbar plexus (Figure 2).

**Table 2:** The length and breadth of tendinous part of Psoas minor muscle

S. No	Tendon length(cm)	Tendon width(cm)
1	11	.5
2	10.5	.5
3	11.5	.5
4	12	.8
5	12	1
6	11	1
7	12.5	.5
8	11.5	.5
9	12	1
10	10	1
11	11	1
12	12	.8
13	12	.5
14	12.5	.5
15	11.5	.5
16	11.6	1
17	11.5	1
18	10.5	.5
19	11	.5
20	10	.4
21	11.5	.8
22	12.5	1
23	12	1.2
24	10.5	1.2
25	11.5	.5
26	11.6	.5
27	11.6	.6
28	12.5	1
29	13	1
30	13.5	1.5



**Fig. 1:** Showing psoas minor muscle with long slender tendon



Fig. 2: Showing the psoas minor muscle tendonous part merged with iliopsoas fascia

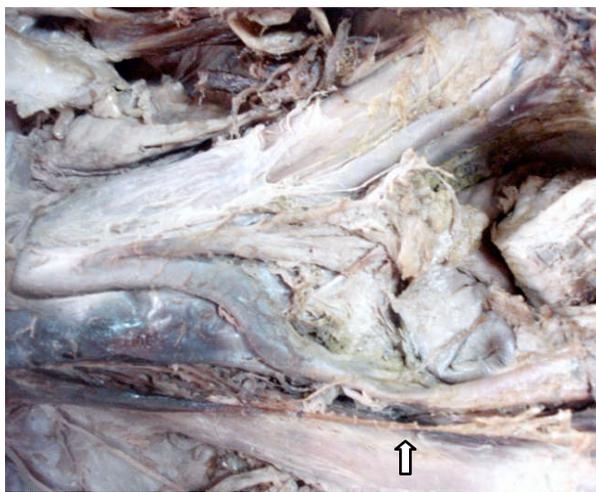


Fig. 3: Showing the psoas minor muscle appearing like a sling

In an another cadaver it was observed that the muscle was very thin, both the fleshy and tendonous part was appearing like a sling (Figure 3).

**Discussion**

In a study by Kraycheter et al, the Psoas minor muscle was present in only 30% of the cases<sup>3</sup>. While in another study by Danillo et al, the presence of the muscle was observed in 59% of the human fetuses<sup>4</sup>. While in the present study the Psoas minor was observed in 60% of the cadaver

	Researcher	Year	Incidence %
1	Snell R.S Kraychete D.C	1993	60%
2	Kraychete D.C	2007	30%
3	Guerra D.R eta	2012	59.9%
4	Danillo	2012	59%
5	Sonali Agichan et al	2013	40%
6	Present	2014	60%

In majority, Psoas minor muscle is deficient similar to commonly absent muscle like

Pyramidalis, Peroneus tertius, Palmaris longus and plantaris<sup>5</sup>.

The psoas minor muscle arises as a fleshy belly arising from the first two lumbar vertebrae and intervertebral disc which was observed in present cases. In a study by Macalister, the author observed variation in origin, where the fibres of the Psoas minor muscle originated as a ramification of the fibres of psoas major in some cases.

Bergman and Afifi showed variations of insertions on the inguinal ligament, femoral neck and lesser trochanter of the femur [6]. In a description by Gardner et al, they reported that this muscle was inserted by means of thin tendon into the iliopubic eminence and arcuate line and that it had an additional insertion into iliac fascia and pectineal ligament [7]. In the present study the thin tendon was long slender flattened at the insertion into iliopectinate line and in cases blended with iliopsoas fascia.

Psoas Minor is found to be consistently absent in those with Trisomy 18. Higher frequency of muscle anomalies in aneuploidy is due to delayed developmental process in them [8].

Psoas minor syndrome is attributed to unusual high tone in Psoas minor muscle and tendon, the patient complains of pain in lower quadrant of abdomen. In this syndrome, there is limited extension; tenotomy is only treatment which relieves the symptoms [8].

**Conclusion**

In the present study, conducted on 30 cadavers, the Psoas minor muscle was observed in 60% of cadavers. It was bilaterally seen in 7 cadavers and unilaterally seen in 5 cadavers. The normal anatomy

and variations were noted. In any lower spine surgeries, the normal and variant anatomy of the muscle is important to note, and if neglected can lead to any complications during the surgery.

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## Cadaveric Oath and Its Relevance for Students of Anatomy

Sharadkumar P. Sawant\*, Shaheen Rizvi\*\*

### Abstract

Physicians and medical students must demonstrate sensitivity, respect, compassion, emotional support, and empathy at all times, to patients and their families. A doctor-patient relationship defines the uniqueness of the medical profession. It can be the most rewarding element of medical practice. But today in this age of technology and cost management, the traditional doctor-patient relationship is eroding. There is a lack of trust between patients' families and doctors. A number of forces have combined to devalue and diminish this doctor-patient relationship. The attainment of the best professional principles, attitudes, expertise, and conduct, during the transformation of a medical student to a practitioner, begins on the first day of medical college and continues throughout. The need of the hour is to retain the best elements of a doctor-patient relationship, and teach it to medical students. This training must be started as soon as a student enters medical college. Hence a subject called as 'Bioethics' has now been introduced into the curriculum. Bioethics education is the best way to achieve the goal of professionalism and it must start in the dissection hall for medical students by taking a 'Cadaveric Oath'. At the outset of the medical curriculum, it is the cadaver which imparts professional principles, knowledge, conduct and altruistic behaviour to a medical student. Hence cadavers are to be held in high esteem and are to be regarded as not only the 'first patient' but also the 'first teacher' of a medical student. To appreciate the altruistic behaviour of a cadaveric donor, which is a fundamental component of professionalism, taking a 'Cadaveric Oath' becomes an essential part of Bioethics. A 'Cadaveric Oath' is a pledge which the students recite on the opening day of Anatomy learning, to respect the dignity and integrity of the human remains that they are about to work on. A cadaveric oath is a unique and essential aspect of the medical curriculum.

This paper discusses the current challenges faced by medical professionals and emphasises the relevance of a 'Cadaveric Oath' as a part of Bioethics in today's age of advanced medical technology. The paper also elaborates the contents of a 'Cadaveric Oath' and the right method of administering it.

**Keywords:** Physicians; Medical Students; Patients; Doctor-Patient Relationship; Bioethics; Cadaveric Oath; First Patient; First Teacher.

### Introduction

Physicians are held in high esteem by society and they are expected to exhibit professional behaviour. A professional responsibility means placing the patient's concerns before their own and making good

medical care of patients, the highest priority. A physician-patient interaction is guided by a 'golden rule' - "do unto others as you would have them do unto you and your family." There should be respect for the patient's dignity, privacy and confidentiality. Physicians and medical students must demonstrate sensitivity, respect, compassion, emotional support, and empathy at all times – to patients and their families. A doctor-patient relationship defines the uniqueness of the medical profession. It can be the most rewarding element of medical practice. Nothing is more satisfying than to "help" an individual patient and receive their heartfelt thanks. But today in this age of technology and cost management, the traditional doctor-patient relationship is eroding.

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There is a lack of trust between patients' families and doctors. A number of forces have combined to devalue and diminish this doctor-patient relationship. There is an increasing expectation from patients that, with modern medicine and technology, a doctor should be able to guarantee a good outcome. When the desired outcome is not achieved, there are attacks on doctors and other medical staff, by angry friends and relatives of patients. The perception is that, any adverse outcome is due to the doctor's negligence. At the same time, patients hear of tales of corruption at medical colleges which further adds to their wrath [1].

Students enter medical colleges with varied personal and cultural milieu. A number of developments occur in the outlook of medical students while they undergo a transformation from being medical students to being practising physicians. The attainment of the best professional principles, attitudes, expertise, and conduct, during this transformation, begins on the first day of medical college and continues throughout their career. These developments are contributed not only by the curriculum, but also by their role models, teaching-learning activities in the classroom, their interactions with peers, faculty, patients, patients' families, other health care providers etc. All these factors influence their professional growth [2]. Hence the academic environment of a medical college, must try to positively direct a medical students' professional growth. They must create an environment which helps in cultivating professional values.

The need of the hour is to retain the best elements of a doctor-patient relationship, and teach it to medical students, in order to preserve this most satisfying aspect of the medical profession. This training must be started as soon as a student enters medical college. Hence a subject called as 'Bioethics' has now been introduced into the curriculum [3].

Anatomy is one of the basic medical science disciplines in the medical undergraduate curriculum which a student encounters as soon as he enters the medical college. Anatomy is a rigorous course requiring great commitment and enthusiasm. Without studying human anatomy in totality, medicine is meaningless. Anatomy is the mother of all medical sciences, and it cannot be thoroughly learnt without the use of cadavers. It is an established fact that students learn Anatomy from the dead. At the outset of the medical curriculum, it is this cadaver which imparts professional principles, knowledge, conduct and altruistic behaviour to a medical student. Hence

cadavers are to be held in high esteem and are regarded as the first patient of a medical student. Cadavers are required for studying human anatomy in all disciplines of medical science. When it comes to training 'doctors of tomorrow' in the science of anatomy, cadavers are indispensable. They convey more than mere facts and information. On the opening day of dissection, the students' are captivated at the first mention of the opportunity of human dissection. Gaining insight and appreciation of the structure of the human body, is a deep profound learning experience for a student. Human structures are complicated and vast. The more a student reads and dissects, the more knowledge he gains [4].

A fundamental component of professionalism is altruism; which is learnt from a cadaveric donor. A cadaver is like the first patient for a student. It emphasizes the humanistic side of medicine and is meant to inculcate in students, the ethos that will, guide them into becoming professional, caring and compassionate doctors. The cadaver belongs to a person who decided to donate his body to make a contribution to society. Students must recognise the generosity of these donors in bequeathing their bodies as 'silent mentors' for medical education. Thus to appreciate this altruistic behaviour of a cadaveric donor, taking a 'cadaveric oath' becomes an essential part of Bioethics [5].

#### *Cadaveric Oath*

An oath is a public statement or promise to behave or not to behave in certain ways.

A 'Cadaveric Oath' is a pledge which the students recite on the opening day of Anatomy learning, to respect the dignity and integrity of the human remains that they are about to work on.

For the process of oath taking, the students should be made to stand around a cadaver, with their right hand lifted up and pointing in the direction of the cadaver. The left hand should hold a copy of the oath. The oath is administered by the Head of the Department. The ceremony should be presided over by the faculty of the department and ideally also by the head of the institute and by a member of the Bioethics Committee.

Taking a cadaveric oath is a good way to start the medical curriculum. It helps to begin a discussion with the students about uprightness and ethical conduct. It is inspiring and makes the new batch of students feel as a part of the scientific community. Oath taking helps students from diverse backgrounds to remember that no matter where they come from, they're all in this together [6].

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*Cadaveric Oath*

I, ....., a student of First MBBS, Batch of ..... K.J. Somaiya Medical College, solemnly pledge to respect the cadaver and treat this once living person with compassion and dignity as I use it to further my professional goals. to show due respect and gratitude towards this cadaver who will always remain my first teacher. to pay gratitude towards the next of kin of the donors for their endeavors in serving society selflessly even after death. to consider this as the best example of Living after Death. to always emulate this act of the donor to provide quality health service to society and to enhance the lives of all mankind.



*Cadaveric Oath*

© Dr. S. P. Sawant, Professor and Head, Department of Anatomy

The cadaveric oath enlightens the student regarding the importance of these once-living bodies and how they should be treated with proper care and respect, and also the fact that Cadavers are their 'silent mentors'. It emphasizes the attitude that a student should always adopt; first as a learner and later as a physician or surgeon.

A cadaveric oath has both an educational role as well as it is designed to foster a selfless attitude of 'giving without recognition' among would-be-physicians. Knowledge and experience of the humanities is a key element of caring for patients. When physicians will, as practising doctors, recollect their cadaveric oath, it will expose them to the human experience of health care that may become lost in the daily activities of technological medicine.

The aim of a cadaveric oath is to turn out caring, informative, and clinically better doctors who would accord each and every future patient, the dignity and respect deserved. Such doctors will also develop sensitively as they improve their knowledge and practical skills and will always consider the 'human' inside the patient [7].

### Discussion

Ethics has today become a crucial part of learning and this message must permeate the educational environment. Regarding a cadaver, there are a number of moral and ethical debates nowadays. A dead person's body has an intrinsic ethical value that



requires a respectful attitude towards it. This ethical dilemma appears when an invasive manipulation or performing a dissection on the cadaver is required.

Dissection of the human body represents a procedure during which the body is sectioned in order to study the topographical anatomy and the structure of its components. Such a procedure represents an important part of medical education; the knowledge of anatomy thus acquired contributes decisively to the specialized training of physicians in general and of future surgeons in particular [8].

[\* File contains invalid data | In-line.JPG \*]

Students should be made aware that these cadavers who are their 'silent mentors' were once alive and were people like them, with dreams, hopes, aspirations, disappointments and despair. Hence they should be treated just as the way a live person is treated, not only as a 'first teacher' but also as the 'first patient'; to treat the cadaver as a simple corpse would mean lowering the evaluation standards applied to the person alive.

When someone is donating their body after death, they are helping to train the next generation of doctors. "This is how good doctors get better. Nothing gets perfected unless it is practiced on cadavers." Also a person who donates his body willingly for the advancement of medical science has done so without anything to gain from it. The students don't know the name of the person they are dissecting, so in a sense it means that the person has given himself up for study without recognition. This is a quality which all medical students or would-be doctors should imbibe i.e. to 'give without recognition'. Hence, it is imperative that the memory of the deceased be respected. The painful and irreversible loss a family has suffered has also to be taken into account [9].

'Silent teachers' speak volumes. Cadavers used in anatomical teaching help health science students to understand not only the structural organisation of the human body but also they help in learning clinical examinations, surgical procedures. They also prepare students for the study of pathology, so as to appreciate the basis of diseases.

Cadaveric oath also emphasizes to the students that they are their first patients. Just like every patient is different, every cadaver is also different just like patients. They are also irreplaceable, unique teachers of the human anatomy. These silent mentors teach by letting students explore the wonders of the human anatomy. No other mode of learning can replace the hands-on experience derived from working with cadavers. Here, students can appreciate three-dimensional anatomy and anatomical variations.

They can have a tactile understanding of real human tissues like arteries, veins, nerves organs, bones. Imagine a surgeon performing a surgical procedure directly on a patient when he has never actually worked on a cadaver [10].

Dissection of a cadaver helps students to develop attitudes of ethics, compassion, and humanism which are indispensable in the medical profession. The patient-physician relationship is based on professionalism and an ethical framework of humanism in which love, charity, and wisdom prevail. Imbibing values like respect, responsibility and gratitude can never be achieved using computer based tools or web based tools for learning anatomy.

Lastly, the study of a cadaver conveys to students an appreciation of mortality, first that of the cadaver and ultimately their own. Cadavers serve to constantly remind the students about the impermanence of life [11].

Some professionals equate a White Coat Ceremony (WCC) to a cadaveric oath. WCC is an educational ritual that is carried out in medical education among all those courses that are required to don the white coat. It brings together first year students with their families and the faculty in a symbol of oath taking, related presentations and their ceremony of donning the white coat. It does not involve a cadaver at all. It is carried out mostly by students of optometry, dentistry, pharmacy and medicine. On the other hand, a Cadaveric oath is to be taken by those students who are going to dissect cadavers [12].

## Conclusion

In the modern era Bioethics has got immense importance. The name itself teaches many facts about life. By taking the oath on the first anatomy day, students will respect not only the dead but also the living. Students will understand that there is life even after death and they will never forget the cadaver as their first teacher in anatomy. Hence a 'Cadaveric Oath' is a unique and essential aspect of the medical curriculum. In order to provide medical care in an ethical and humane way, physicians need to be *better* educated about specific aspects of ethical medical practice and learn to think critically about the increasingly complex world of medical practice. Bioethics education is the best way to achieve this goal and it must start in the dissection hall for medical students by taking a cadaveric oath. Later Bioethics education can be carried out for students in a clinical setting as well as for interns, residents and continuing medical education for practicing doctors.

*Competing Interests*

The authors declare that they have no competing interest.

*Authors' Contributions*

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

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## Variation of the Left Gastric and Right Inferior Phrenic Arteries: Its Clinical Implication

Surekha Dilip Jadhav\*, Balbhim Ramchandra Zambare\*\*

### Abstract

The celiac trunk is a short, wide ventral branch of the abdominal aorta which is only about half an inch long and trifurcates into left gastric, common hepatic and splenic arteries. The left gastric artery is the smallest and most variable branch of celiac trunk. During the routine dissection of the upper abdominal region of 64 year old male cadaver, we observed that left gastric and right phrenic arteries had a common trunk which originated directly from the right anterolateral aspect of abdominal aorta while the common hepatic artery and splenic artery arose as a common trunk (hepato-splenic trunk) from left anterolateral aspect of abdominal aorta. This variation is clinically important while performing abdominal surgery especially supracolic organs and diagnostic angiography.

**Keywords:** Left Gastric Artery; Celiac Trunk; Abdominal Aorta; Common Hepatic Artery; Splenic Artery; Inferior Phrenic Artery.

### Introduction

The celiac trunk (CT) is a short, wide ventral branch of the abdominal aorta which is only about half an inch long and trifurcates into left gastric, common hepatic and splenic arteries. The left gastric artery (LGA) is the smallest branch of CT. It passes upwards and to the left behind the omental bursa to reach the cardiac end of stomach [1]. Inferior Phrenic arteries are the first branch of the abdominal aorta which supply the diaphragm and suprarenal glands. They arise just above the CT and pass supero-laterally over the crus of the diaphragm near the superior margin of the suprarenal gland and give superior suprarenal artery [2]. Main classical branches of the CT are usually present in 75 to 90 % and the LGA is the branch in 90% of cases [3,4]. The LGA may arise directly from the abdominal aorta in 0.5 to 15% cases [5]. Usually, the vascular variations are asymptomatic and they are identified accidentally during surgery,

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diagnostic angiography or during cadaveric dissection. The aim of this paper is to describe the rare variation that, the left gastric and right inferior phrenic arteries had a common trunk which was originating directly from the right anterolateral aspect of the abdominal aorta. This variation is clinically important while performing abdominal surgery especially supra-colic organs and diagnostic angiography.

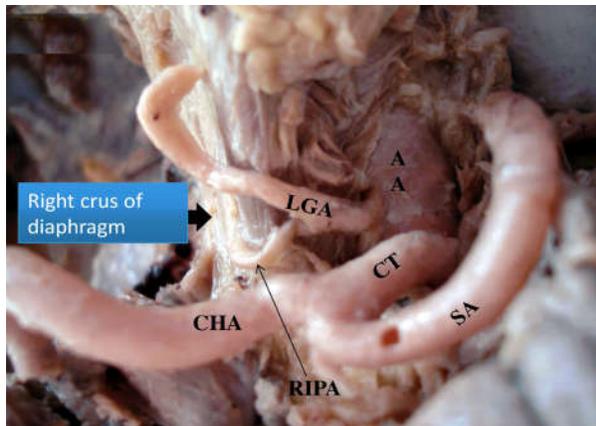
### Material and Methods

During the routine dissection of the upper abdominal region of 64 year old male cadaver at our college, we observed that left gastric and right inferior phrenic arteries had a common trunk which originated directly from the right anterolateral aspect of the abdominal aorta while the common hepatic artery and splenic artery arose as a common trunk (hepato-splenic trunk) from left anterolateral aspect of the abdominal aorta.

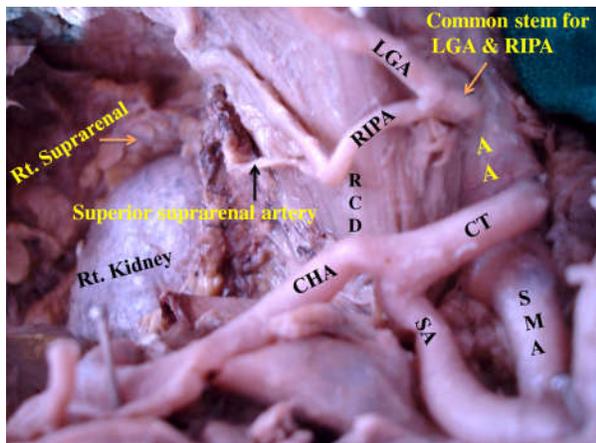
### Case Report

We observed a variation of the left gastric and right inferior phrenic arteries. Both had a common trunk which was originating directly from the right

anterolateral aspect of the abdominal aorta 10 mm above the CT (Figure 1). Right inferior phrenic artery passes to the right over the right crus of the diaphragm and it gave right superior suprarenal artery (Figure 2). CT was arising left antero-lateral aspect of the abdominal aorta. Common trunk of CT was about 24 mm long, and then it was dividing into common hepatic and splenic arteries (Figure 1, 2). The diameters of common trunk of LGA and inferior phrenic artery and CT were 3 mm and 1.2 mm respectively.



**Fig. 1:** showing common trunk for left gastric and right inferior phrenic arteries and bifurcation of celiac trunk. LGA: left gastric artery; AA: abdominal aorta; CT: celiac trunk; SA: splenic artery, RIPA: right inferior phrenic artery; CHA: common hepatic artery



**Fig. 2:** showing right superior suprarenal artery arising from the right inferior phrenic artery. LGA: left gastric artery; RIPA: right inferior phrenic artery; RCD: right crus of the diaphragm; AA: abdominal aorta; CT: celiac trunk; SA: splenic artery; CHA: common hepatic artery; SMA: superior mesenteric artery.

## Discussion

Tripus Halleri i.e. trifurcation is the normal appearance of CT [6]. Out of three branches of CT, the LGA is the most variable branch whose origin varies between the aorta and anywhere along CT up to a

trifurcation [7]. LGA may arise directly from abdominal aorta and may give one or both of the inferior phrenic arteries or a common trunk for both. Sometimes it gives an accessory left hepatic artery in 8-25 % or may replace the left hepatic artery in 11-12% [8]. Literature describes classification of the anatomical variations of CT. Loukas et al. (2006) reported hepatosplenic trunk with separate LGA which gave accessory left hepatic artery [4]. Variable incidence of origin of LGA was reported by researchers in cadaveric dissection studies as shown in Table 1.

**Table 1:** showing the incidence of left gastric artery from aorta

Author	Incidence (%)
Rossi [8]	5
Eaton [9]	6.7
Michels [10]	2.5
Kiss[11]	0.5
Lippert and Pabst [12]	3
Vandamme and Bonte [3]	6
Present study	1.6

Naidich et al. (1980) studied the origin of the LGA by evaluating 500 celiac angiograms. They reported that in 2.6% it arose as a direct branch of the aorta [13]. An accessory LGA may arise from the left hepatic artery in 14.2% cases as reported by Nakamura et al. (2011) by studying the hepatic angiograms [14]. We observed that, common trunk for left gastric and right inferior phrenic arteries which arose from right anterolateral aspect of the aorta. Also, right inferior phrenic artery gave right superior suprarenal artery (Figure 1, 2). This type of variation is very rare and it should be kept in mind while performing surgeries in upper abdominal region.

Upper gastro-intestinal hemorrhage is from LGA territory in 85% of cases. In upper gastro-intestinal bleeding when no active bleeding site identified after angiography then prophylactic embolisation of LGA may be performed and it is well tolerated because of rich collateral blood supply [15]. Also, LGA embolization is used for weight loss with safety and efficacy in man [16]. Lymph node metastasis along LGA in gastric cancer is higher. Knowledge of anatomical variations of LGA is essential while performing perivascular lymph node dissection [17].

## Embryological Explanation

Ventral splanchnic arteries which arise from paired dorsal aorta supply the digestive tube. Initially vitelline arteries are number of paired vessels supplying yolk sac. These arteries gradually fuse. In adult they are represented by celiac trunk, superior mesenteric artery and inferior mesenteric artery.

During development of alimentary tract many patterns of the disappearance of ventral splanchnic arteries and of their anastomosis occur. When one of the main branches of CT shifts to aorta that time a gastrosplenic, hepatosplenic or hepatogastric trunk is formed. Sometimes, all the main branches arise separately and CT is absent or it may fuse with superior mesenteric artery to form celiacomesentric trunk [3, 9, 17].

Trandler (1904) gave the embryological explanation for variation of ventral branches. Longitudinal anastomosis between the four roots of the omphalomesentric artery is responsible for variation of ventral branches. The left gastric, common hepatic and splenic arteries originate at this longitudinal anastomosis and they are separated from fourth root i.e. the future superior mesenteric artery. If the second and third roots remain persistent then it gives rise to separate origin of celiac branches from aorta [18]. In present case the first root had not united with second root which resulted into development of LGA directly from the aorta while common hepatic and splenic arteries developed from second root as a common trunk i.e. hepato-splenic trunk.

### Conclusion

LGA is the most variable branch of the CT than other branches. Present case report will be very useful for laparoscopic surgeries and diagnostic angiography. The identification of anatomic vascular abnormalities of the coeliac trunk and its branches in modern oesophago-gastric surgery is very important and angiography should be mandatory when complex surgeries are planned which will prevent the iatrogenic vascular trauma and complications during surgery.

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## Nerve Blood Flow in Diabetic Peripheral Neuropathy- Revisiting the 'Vasa Nervorum' Hypothesis

Senthil P. Kumar

### Abstract

The aim of this short communication article was to highlight the role of altered nerve blood flow as a patho-anatomical manifestation in diabetic peripheral neuropathy (DPN), a common microvascular complication of globally prevalent metabolic disorder, diabetes mellitus. Limited evidence suggested that higher epineurial blood flow was present in DPN, which indirectly influenced impairments in exercise-induced nerve conduction increments. Newer methods like Nerve photography and fluorescein angiography provide useful objective information on nerve blood flow in terms of epineurial vessel pathology score, epineurial arteriovenous shunting, nerve fluorescein appearance time and intensity of fluorescence. Treatments using Adenosine and adenosine A2A receptor agonist, and alpha-lipoic acid administration were shown to be beneficial, with dose-dependent effects on nerve blood flow.

**Keywords:** Neuroanatomy; Vascular Neurology; Epineurial Circulation; Neural Hemodynamics.

The aim of this short communication article was to highlight the role of altered nerve blood flow as a patho-anatomical manifestation in diabetic peripheral neuropathy (DPN), a common microvascular complication of globally prevalent metabolic disorder, diabetes mellitus.

Eaton et al [1] compared epineurial haemodynamics (epineurial intravascular oxygen saturation and blood flow) in patients with 11 chronic painful and eight painless neuropathy subjects. Intravascular oxygen saturation was found to be higher in the painful neuropathy group compared to those without pain. Faster Fluorescein rise time in those with painful symptoms also indicated higher epineurial blood flow in those subjects.

Nerve photography and fluorescein angiography: Tesfaye et al [2] developed newer techniques of sural nerve photography and fluorescein angiography as an index of nerve blood flow and studied 13 subjects

with chronic sensory motor neuropathy, five non-neuropathic diabetic and nine normal control subjects. The study had following findings; "The mean epineurial vessel pathology score of the neuropathic group was significantly higher than the combined normal control and non-neuropathic diabetic groups. Direct epineurial arteriovenous shunting was observed in six neuropathic and one non-neuropathic diabetic patients and not in any of the normal control subjects. The nerve fluorescein appearance time was significantly delayed in subjects with chronic sensory motor neuropathy compared to both normal and non-neuropathic diabetic subjects. The mean intensity of fluorescence at 96, 252 and 576 s, was significantly lower in subjects with chronic sensory motor neuropathy compared with other two groups."

Exercise-induced responses: Tesfaye et al [3] recorded sural sensory conduction velocity in 12 non-neuropathic diabetic subjects, 15 diabetic subjects with established neuropathy and 16 age-matched normal control subjects, before and after exercise to 80% age/sex predicted maximum heart rate, and concluded that the impairment of exercise-induced nerve conduction increment in diabetic neuropathy indirectly implicated impaired nerve blood flow in diabetic neuropathy.

Adenosine and adenosine A2A receptor agonist: Kumar et al [4] examined the effects of chronic

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administration of adenosine and CGS 21680 hydrochloride (adenosine A<sub>2A</sub> receptor agonist) on motor nerve conduction velocity (MNCV), nerve blood flow (NBF) and histology of sciatic nerve in DPN rats. Adenosine (10 mg/kg, i.p.) Showed improvements in sciatic MNCV and NBF in diabetic rats while CGS 21680 (0.1 mg/kg, i.p.) significantly improved NBF; but not MNCV.

**Lipoic acid:** Nagamatsu et al [5] studied the effects of lipoic acid (LA) on oxidative stress in diabetic peripheral nerves of rats by measuring nerve blood flow (NBF), electrophysiology, and indexes of oxidative stress. LA was shown to have dose-dependent influence on NBF in diabetic nerves, but not on normal nerves.

Stevens et al [6] reported therapeutic effects of administration of the antioxidant DL-alpha-lipoic acid (LA) to streptozotocin-injected diabetic rats, as follows; "LA improved digital sensory but not sciatic-tibial motor NCV, corrected endoneurial nutritive but not composite NBF, increased the mitochondrial oxidative state without correcting nerve energy depletion, and enhanced the accumulation of polyol pathway intermediates without worsening myo-inositol or taurine depletion."

Limited evidence suggested that higher epineurial blood flow was present in DPN, which indirectly influenced impairments in exercise-induced nerve conduction increments. Newer methods like Nerve photography and fluorescein angiography provide useful objective information on nerve blood flow in terms of epineurial vessel pathology score, epineurial arteriovenous shunting, nerve fluorescein appearance time and intensity of fluorescence. Treatments using Adenosine and adenosine A<sub>2A</sub>

receptor agonist, and alpha-lipoic acid administration were shown to be beneficial, with dose-dependent effects on nerve blood flow.

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- Uniformly American English

- Abbreviations spelt out in full for the first time. Numerals from 1 to 10 spelt out
- Numerals at the beginning of the sentence spelt out

### Tables and figures

- No repetition of data in tables and graphs and in text.
- Actual numbers from which graphs drawn, provided.
- Figures necessary and of good quality (color)
- Table and figure numbers in Arabic letters (not Roman).
- Labels pasted on back of the photographs (no names written)
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