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Original Article

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Study of Anatomical Variations of Profunda Femoris Artery in the Indian Population

A Manitombi Devi[1], Sushil Kumar[2], Debasis Bandopadhyay[3]

Abstract

Introduction: The femoral artery is commonly used for angiographic procedures. The Profunda femoris artery (PFA) is the largest branch of femoral artery. The knowledge of anatomical variation of PFA is clinically significant in view of most angiographic diagnostic procedures being performed in this region. A high origin of PFA is closely related with femoral nerve and its branches posing immense challenge to re-vascular surgeon in this region. *Objective:* To study the variation of PFA with respect to its origin, distance of origin from mid inguinal point and the direction of origin. *Methods:* A total of 30 femoral triangles were dissected in 15 human cadavers. The PFA was identified and its source, site and direction was noted. *Results:* The PFA originated from the postero lateral aspect of the femoral artery in 53.33%, lateral aspect in 33.33%, posterior aspect in 10% and from the anterolateral aspect in 3.33% of the cases. The PFA was found to originate from external iliac artery in 10% cases (3 out of 30) out of which the variation was seen bilaterally in one cadaver. The mean distance of origin of PFA from the mid inguinal point is 23 mm. *Conclusion:* Knowledge in the anatomical variations of the PFA helps the clinician to avoid iatrogenic injury while performing various procedures like angiography, venous excess for femoral vein, femoral nerve block. Pseudo aneurysms can occur when the puncture site is the PFA or Femoral artery distal to the origin of the PFA.

Keywords: Femoral artery; Profunda femoris artery.

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Introduction

Profunda Femoris Artery (PFA) is the largest branch of femoral artery which arises from lateral side of femoral artery 3.5 cm distal to inguinal ligament. The PFA is the chief supply to the extensor, adductor and flexor muscles of the thigh, and it also anastomoses with the internal iliac artery above and with the popliteal artery below. It gives lateral and medial circumflex femoral arteries from lateral and medial aspect respectively in the proximal part of the thigh and gives multiple muscular and perforating branches more distally. The direction of origin of the profunda femoris is variable, at times it arises medially or less commonly from the posterior aspect of femoral artery [1]. The femoral artery is used for multiple clinical procedures like arteriography, digital subtraction angiography, Doppler imaging, ultrasound, and magnetic resonance imaging [2]. In the vascular surgical literature, the femoral artery proximal to the origin of the profunda branch is referred as the common femoral artery, and the vessel distal to the branch is termed as the superficial femoral artery [3]. PFA displays variations with respect to the point of origin, course and branches. These variations have received attention of not only the anatomist

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but also surgeons, radiologists and cardiologists. Origin of PFA from femoral artery may be at a short distance distal to inguinal ligament or it may arise as a separate vessel behind the inguinal ligament. Higher the origin of PFA greater is the risk of iatrogenic injury during surgical procedures [4]. Any variation in PFA should be kept in mind to prevent unexpected and avoidable complications. So, PFA with respect to its origin, distance of origin from mid inguinal point and the direction of origin was studied in detail in this study.

Aim

To study the anatomical variations of Profunda Femoris Artery in Indian population.

Objective

1. To study the variation of PFA with respect to its origin, distance of origin from mid inguinal point and the direction of origin.
2. To compare the findings of our study with other studies done in various diverse population.

Material and Methods

We selected 30 formalin embalmed lower extremities of 15 adult human cadavers of Indian origin in an age range of 67-98 years. Sexual dimorphism was not part of the study. The bony landmarks anterior superior iliac spine (ASIS) and pubic symphysis (PS) were identified. The distance between ASIS and PS was measured with scale and the midpoint of this distance was taken as mid-inguinal point (MIP). Careful dissection of femoral triangles was carried out to identify the profunda femoris and circumflex femoral arteries. Their source of origin, direction and distance were noted from mid-inguinal point (MIP) which was taken as reference point. All measurements were recorded by a single observer to minimize the observational errors. The measurements were done using calibrated scale and quantified in millimetres. The data was expressed as range, mean values and percentage.

Results

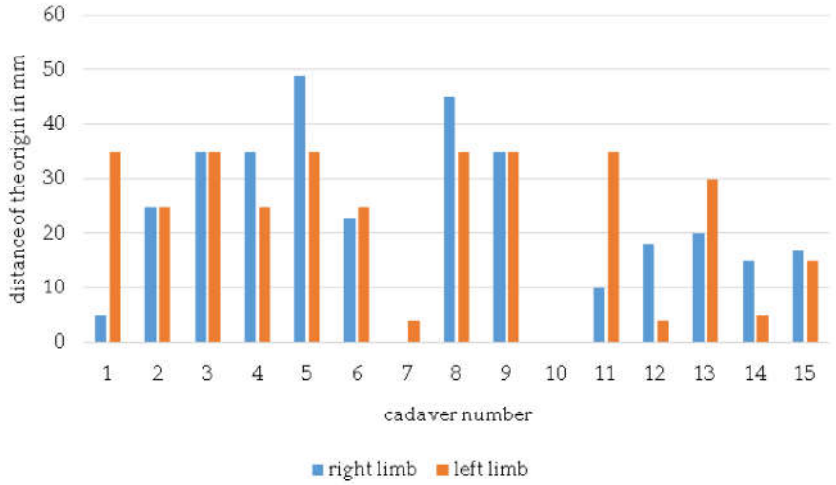
The PFA originated from the postero-lateral aspect of the femoral artery in 16 out of 30 cases (53.33%), lateral aspect in 10 out of 30 cases (33.33%), posterior aspect in 3 out of 30 cases (10%) and from antero-lateral aspect in 1 out of 30 cases (3.33%). The PFA was found to originate from external iliac artery in 3 cases emerging at inguinal ligament as two separate vessels. This variation was seen bilaterally in a 77 years old female cadaver. In one case the left circumflex femoral artery was found originating along with the PFA at the mid inguinal point (Fig 1). The mean distance of origin of PFA from the mid-inguinal point was 23 mm in this study with distance ranging from minimum 0 to a maximum of 49 mm. The mean distance was 22 mm in right side of the limb and 23 mm in the left side of the limb. The varying distances of origin of PFA from MIP has been depicted vide Graph 1. Symmetry in both sides of limb as per all three parameters (site of origin, distance from mid inguinal point and the direction of origin) was observed in 3 out of 15 cadavers. In one case the PFA originated in same distance from mid inguinal point on both sides but emerged in different directions. The direction of origin is shown in Table 1.

Table 1: Table showing the direction of origin of PFA from Femoral artery

S No	Direction of Origin	Frequency	Percentage
1	Posterolateral	16	53.33%
2	Lateral	10	33.33%
3	Posterior	3	10%
4	Anterolateral	1	3.33%

Table 2: Comparisons of origin of PFA in current study with the previous studies.

Studies	Distance between MIP and the origin of PFA
Dixit et al. (2001)	41-52 mm (Rt), 46-54 mm (Lt)
Prakash et al. (2010)	4.2 cm
T Manjapa et al. (2011)	3.56 cm
Daksha et al. (2011)	31-40 mm (Rt), 41-50 mm(Lt)
Sabnis et al. (2013)	3.2 cm
Ahire et al. (2014)	4.3±1.13 cm (Rt), 4.3±1.08 cm (Lt)
Present study	23 mm



Graph 1: Showing the distance of PFA origin from the mid inguinal point.

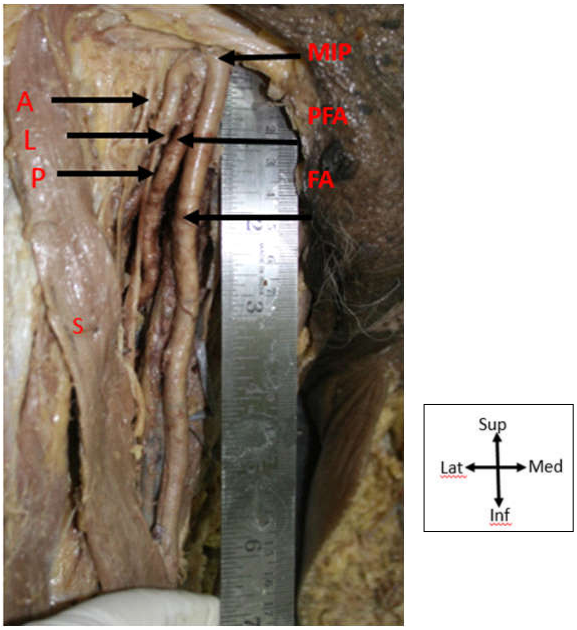


Fig 1: Photograph showing the origin of PFA along with left circumflex femoral artery at the mid inguinal point. MIP- Mid inguinal point, FA- Femoral artery, PFA- Profunda femoris artery L- lateral circumflex femoral artery, A- anterior division of femoral nerve, P – posterior division of femoral nerve, S- Sartorius.

Discussion

Femoral artery is a common site for angiographic procedures. Many previous studies found PFA arising commonly from postero-lateral aspect as noted by Dixit et al. in 2001 and other studies [3,5,6]. The profunda femoris artery in our study also originated commonly from the postero-lateral side of the femoral artery in 53.33%, lateral aspect in 33.33%, posterior aspect in 10% and anterolateral aspect in 3.33% cases. These findings were similar with the data available in literature.

The average distance of origin of profunda femoris artery from the mid inguinal point in our study was 23 mm as compared to 35 mm mentioned in Gray's Anatomy by Susan Standring and other studies (Table 2). This difference in mean distance might be because of the high origin of PFA noted in 3 cases where the PFA was found to originate from external iliac artery emerging as two separate vessels behind the inguinal ligament. This finding was seen bilaterally symmetrical in a cadaver.

The high origin of PFA was also noted in previous study by Daksha et al. in 2011 [5] and other studies [4,7,8,9,10]. In one cadaver the PFA originate at the MIP along with the LCFA. Similar findings have been noted by Daksha et al. in 2011 [5]. Since our study had a lower sample size the mean distance calculated could have been less when compared to data of previous studies.

Developmentally the axis artery of the lower limb is derived from the fifth lumbar segmental artery which runs in the dorsal aspect of the limb. The femoral artery is a new vessel formed in the ventral aspect which fuses with the external iliac proximally and the popliteal artery distally [12]. The presence of variations of the lower limb vessels can most often be explained as an abnormal development of the arterial network of the lower limb in the embryo.

Conclusion

Knowledge about the possibility of the anatomical variations of the PFA will help the clinician to avoid unwanted and preventable iatrogenic injuries while performing various procedures like angiography, venous access for femoral vein and femoral nerve block. Pseudo aneurysms can occur

if PFA or femoral artery distal to the origin of the PFA is punctured. The knowledge of variations in high origin of PFA and its branches and distribution is of immense importance to prevent flap necrosis of tensor fascia latae which is commonly used in plastic and reconstructive surgery. Anatomical variations should be considered before planning different diagnostic and therapeutic interventions on femoral artery and its branches as the vessels and the nerve are closely related in the femoral triangle.

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Original Article

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Study of Sacral Index: Comparison between Different Study

Pankaj B Maheria[1], Kuldeep N Suthar[2]

Abstract

Introduction: Identification of sex by human skeletal remains is very important in anthropological and medico legal works. Over the years different authors had carried various types of measurements on dry human sacrum. *Materials and Methods:* The present study carried out on 50 sacra of unknown sex contains 24 male and 26 female sacra identified by physical characteristics. They were collected from Gujarat. Parameters like maximum sacral length and maximum sacral breadth were measured on the sacrum and sacral index calculated by that. *Results*: In present study the mean of sacral length in male is 102.58 mm and in female 111.74 mm. The mean of sacral breath in male is 103.21 mm and in female 102.34 mm and the sacral index is 99.68 in male and 109.36 in female. This index was compared with similar studies from Gujarat and other parts of India. *Conclusion*: Sacral index and sacral length both are statistically significant. So from sacrum it is possible to identify sex and also help in medicolegal aspects.

Keywords: Sacrum; Sacral Index; Maximum sacral length; Maximum sacral breadth.

How to cite this article:
Pankaj B Maheria, Kuldeep N Suthar. Study of Sacral Index: Comparison between Different Study. Indian J Anat. 2019;8(1):9-11..

Introduction

The best indicators of sex in the skeleton are to be found in the pelvis. This is because one of the major biological differences between women and men, that of having babies of that part of the body. The sacrum (Latin–sacrum = sacred) is a large flattened triangular /wedge shaped bone formed by the fusion of five sacral vertebrae. Sacrum is an important bone for identification of sex in human skeletal system, because the bones of the body perish after the enamel of teeth after death. For sex determination of human skeletal remains, sacrum always captured the attention in forensic science experts and anthropologists. Accuracy of sex identification based on the study by Krogman [1] Entire skeleton is 100%, pelvis plus skull is 98%, pelvis alone 95%, skull alone 90% and long bones alone 80%. Most anatomists do not claim 100% accuracy even when skeleton is available. Morphological features over the bones also depend on the geographic, nutritional and occupational factors. Thus, present study aims at determining the significance of sacral index in sex determination and compares the findings with different races according to literature available. The accurate method for identification of femaleor male type sacrum has often been the sacral index method as explained in the Hrdlicka's practical Anthropometry [2].

The formula for Sacral Index is: Maximum width X 100 / Maximum straight length

The sacral index compares sacral breadth (between the most anterior points on the auricular surfaces) with sacral length (between midpoints on the anterior margins of the promontory andapex): average values for males and females are 105% and 115%, respectively [3].

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Materials and methods

The study was conducted on 50 dry human sacra procured from Department of Anatomy, GMERS Medical College, Patan and Vadnagar, Gujarat. All the measurements were taken with the help of digital Vernier caliper. All measurements were taken in millimeters. Following parameters were studied: -

1. Maximum length of sacrum: (anterior straight length-SL)

It measures the straight distance from sacral promontory in the mid sagittal plane to the middle of the anterior-inferior border of the last sacral segment.

2. Maximum breadth (width) of sacrum:

By taking two points at the lateral most part of the ala of sacrum.

***3. Sacral index** = maximum breadth X 100/ maximum length*

Mean, standard deviation, range were calculated and data was statistically analyzed.

Results

The mean of sacral length in male is 102.58 mm and in female 111.74 mm (Table 1). The mean of sacral length is greater in female than male. The mean of sacral breadth does not have much difference between male and female which was 103.21 mm in male and 102.34 mm in female (Table 1). So difference found significant statistically in length but not in breadth. Sacral index is 99.68 in male and 109.36 in female (Table 1). Sacral index in male is lesser than female. This difference found statistically significant.

Here I am depicting some important figures. Figure 1 showing how we taken measurement of length of sacrum by digital Vernier caliper and

Table 1: Measurements of sacrum in the present study

Sr. no.	Parameter	Sex	Range	Mean	SD
1	Length of sacrum (mm)	Male	98.18 – 106.57	102.58	3.21
		Female	101.87 – 119.73	111.74	7.21
2	Breadth of sacrum (mm)	Male	93.38 – 112.49	103.21	6.94
		Female	93.87 – 110.95	102.34	6.56
3	Sacral Index (%)	Male	92.54 – 106.94	99.68	5.7
		Female	102.84 – 121.80	109.36	7.28

Table 2: Comparative study of Sacral Index with previous studies

Sr. no.	Investigator	Male Sacrum			Female Sacrum		
		No	Mean SI	Range	No	Mean SI	Range
1	Present study	24	99.68	92.54 – 106.94	26	109.36	102.84 – 121.80
2	Mishra SR et al.	74	98.21	90 - 108	42	117.84	103 – 131.25
3	Patel MM et al.	32	96.21	90.5 - 108	32	113.25	104.8-131
4	Raju PB et al.	33	100.85	74.72 – 126.9	11	111.39	88.38 – 134.4
5	Poornima J et al.	81	104.08	81 – 136	64	115.72	85 – 146
6	Mamatha H et al.	25	115.92		25	125.2	
7	Rajpura P et al.	50	101.26	81.23 - 109.61	50	116.18	105.32 – 134.79

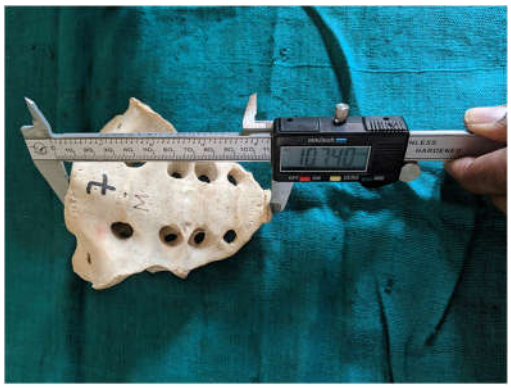

Fig. 1: Measurement of Length of sacrum

Fig. 2: Measurement of Breadth of sacrum

Figure 2 showing how we taken measurement of breadth of sacrum by digital Vernier caliper.

Discussion

Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other and are manifestation of the internal structure and tissue components which in turn, are influenced by environmental and genetic factors. Human sacrum is one of the important bone used for identification of gender. In general, the mean of Sacral Index was higher in females than in males.

If we compare the mean value of sacral index in previous studies, mean of male sacral index is higher than P at el. MM et al. [4] and Misra SR et al. [5] but is lesser than Raju PB et al. [6], Poornima J et al. [7], Mamatha Het et al. [8] and Rajapur P. et al. [9]. (Table 2).

Mean of female sacral index is lesser than Misra SR et al. [4], Patel MM et al. [5], Raju PB et at. [6], Poornima J et al. [7], Mamatha H et al. [8] and Rajapur P. et al. [9] (Table 2).

The present study showed that according to sacral index method 79.17% (19 numbers) of male sacra were identified and 65.38% (17 numbers) female sacrum were identified accurately. Patel MM et al. [5]. Showed 62.5% male sacra and 68.75 of female sacra were identified using sacral index method. Rajapur P. et al. [9] all also showed that 84% of male sacra and 70% of female sacra were identified using the sacral index method.

Conclusion

The present study showed the significant difference in sacral index of male and female. Hence it can be concluded thatsacral index is reliable criteria for difference of sex from sacrum and its use.

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Indian Journal of Forensic Medicine and Pathology	Quarterly	16000	15500	1250	1211
Indian Journal of Forensic Odontology	Semiannual	5500	5000	430	391
Indian Journal of Legal Medicine	Semiannual	8500	8000	664	625
International Journal of Forensic Sciences	Semiannual	10000	9500	781	742
Journal of Forensic Chemistry and Toxicology	Semiannual	9500	9000	742	703
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Indian Journal of Medical Psychiatry	Semiannual	8000	7500	625	586
Indian Journal of Biology	Semiannual	5500	5000	430	391
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Indian Journal of Waste Management	Semiannual	9500	8500	742	664
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Journal of Social Welfare and Management	Triannual	7500	7000	586	547
International Journal of Food, Nutrition & Dietetics	Triannual	5500	5000	430	391
Journal of Animal Feed Science and Technology	Semiannual	7800	7300	609	570
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Semitendinosus Tendon Size as Graft and Anthropometry in West Coast Population of India

Balakrishna Shetty[1], Sweekritha Shetty[2], Mithun Shetty[3]

Abstract

Introduction: Need of minimum length and diameter of graft for Anterior Cruciate Ligament (ACL) reconstruction and possible predictability with anthropometric parameters. Semitendinosus as solitary tendon is the preferred choice among all the grafts in recent years. Quadrupled tendon graft requires certain length of the tendon. Pre- operative assessment of graft size helps in planning of procedure. *Materials and Method:* In this prospective study 68 (57 Male and 11 Female) patients undergoing ACL reconstruction using hamstring tendons were included. All the anthropometric parameters like height, weight, age, sex, BMI were recorded preoperatively. Intra operatively tendon length and its quadrupled (by folding the tendon on itself) diameter is measured. *Results:* Average length of tendon was 27 cm and quadrupled diameter 7 mm. Semitendinosus tendon length was adequate in 52% of patients in our study. In female patients only 18% had adequate tendon length. Quadrupled diameter was adequate (7 mm or more) in all the patients. This Indicates that tendon length has no relation to diameter. Height is the only parameter indicative of tendon length in both sexes. Weight/BMI were moderate indicator of thickness or diameter in both the sexes. In our study all those of the height 170 cm or more had adequate tendon length and diameter. *Discussion:* Semitendinosus tendon length is predictable as the study shows strong relation to height of the individual. Similar observations made in other studies on Indian population. Diameter or the thickness is moderately related to BMI. Thickness of tendon in our local population is adequate.

Keywords: Semitendinosus; ACL reconstruction; anthropometry; quadrupled diameter.

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Introduction

Arthroscopic cruciate ligament reconstruction has given promising outcomes in overcoming the functional instability caused by cruciate ligament tears sustained during recreational activities or other traumatic events. Reconstructive procedures for cruciate ligaments of the knee utilize hamstring tendons as autograft or allograft [1]. Bone-patellar-bone and quadriceps tendon are other graft options available, but have their own disadvantages such as donor site morbidity, impairing extensor mechanism and anterior knee pain [1,2]. It has been observed that graft diameter plays a major role in success of reconstructive procedures [3]. Patellar bone-tendon-bone and quadriceps tendon graft of appropriate thickness can be harvested as per surgeons need intra operatively [1]. However, hamstring graft thickness varies considerably in different individuals. Multiple looping of sufficiently long tendon can be done to improve the thickness of the graft [2]. Hence it necessitates preoperative methods of assessing graft size (length and diameter) [1]. Imaging techniques for predicting hamstring graft size preoperatively have not been highly effective [3].

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Advent of latest techniques and modern devices of graft fixation has allowed the use of short graft lengths sufficient enough for reconstruction [4]. Final graft construct length of 7 cm and diameter of 7 mm is considered optimal for Anterior Cruciate Ligament (ACL) reconstruction. Graft length of 7 cm would provide 2 cm of graft length for femoral tunnel, 2 cm of graft length for tibial tunnel and 3 cm of intra articular graft length, which is considered optimal [2]. Semitendinosus graft can be quadrupled (folded over four times), if the harvested tendon measures between 28 – 30 cm in length. Inadequacy of graft size compels augmentation of graft with additional tendon. Since the harvested hamstring graft size is highly protean, preoperative prediction of graft size would provide information regarding the need of alternative graft. So the present study was designed to assess the correlation between anthropometric variables and hamstring graft in the tertiary care hospital which is also a referral centre for neighbouring districts of costal Karnataka and northern part of Kerala.

Anatomy of Anterior cruciate ligament (ACL) and graft properties-

Anterior cruciate ligament (ACL) acts as a static stabilizer of knee preventing anterior translation of tibia throughout range of motion [5]. ACL has its femoral attachment in the medial surface of lateral femoral condyle and is inserted medial to intertubercular ridge between medial and lateral tibial spines [6]. The length of ACL ranges between 25 and 41 mm (average 38 mm) and the width of the ligament ranges between 7 and 12 mm(average 10 mm) [2]. However, ACL width is not uniform throughout the length of the ligament, it is broader at the attachment sites and narrowest at the mid-substance. Functionally ACL is considered to be made of anteromedial and posterolateral bundles referenced according to their relative insertions on tibia [6]. However single bundle ACL reconstruction is considered effective enough to restore native anatomy and kinematics of knee [7]. There was not much difference in the functional outcomes of ACL reconstructed using isolated semitendinosus tendon (ST) and those reconstructed using combined Semitendinosus and gracilis (STG) tendon construct. Since rotational forces are better resisted by isolated multilooped ST graft and sparing of gracilis, it is suggested to use semitendinosus graft alone for ACL reconstruction, especially in sports which require full flexion and maximum rotational strength [8]. Gracilis tendon augmentation might be necessary when graft thickness with semitendinosus alone is not adequate [3]. It is essential to have a sound knowledge regarding the anatomy of these tendon insertion sites to avoid technical difficulties in isolating and harvesting the tendons for reconstructive procedures [9]. Semimembranosus, semitendinosus and the long and short heads of the biceps femoris are posterior compartment group of muscles of the thigh, colloquially termed as "hamstrings". Ischial tuberosity serves as a common site of origin for hamstring group of muscles except for the short head of biceps femoris, which originates from linea aspera of femur [10]. Semitendinosus is a fusiform muscle originating from ischial tuberosity and inserted on the anteromedial surface of tibia. Semitendinosus along with gracilis and sartorius form a confluence of tendinous structure in a radiating pattern to resemble a goose foot, hence named as "pes anserinus" [11]. These group of muscles are known as guy ropes of lower limb. They contribute to the flexion of knee and provide rotatory stability furthermore act as a valgus constraint at knee. Sparing of gracilis is justifiable since it is known to compromise dynamic stability for rotational forces [8]. However the contractile capability of semitendinosus and gracilis muscles is known to restore even after being harvested for grafting [12]. Due to limited morbidity associated with harvesting hamstring tendons, they are preferred grafts for ACL reconstruction [1]. Despite the advantages, obtaining adequate size of the hamstring graft is challenging, hence it is imperative to preoperatively assess the size of the graft. This study aims at finding the correlation between anthropometric factors and semitendinosus graft size.

Material and Methods

Study design and participants: The present study was conducted among 68 patients undergoing reconstruction of cruciate ligaments using semitendinosus tendon or both semitendinosus and gracilis as auto grafts at tertiary care teaching hospital of the region during a span of two years.

Study instrument: A questionnaire was developed after doing an extensive search of literature and by consulting experts in respective field. Alterations were done to the pro forma based on the feedback obtained after pilot study. The questionnaire consisted of three sections. The first section consisted of demographic profile. The second section consisted of clinical details. The final section consisted of various anthropometric measurements which included height, weight, age, sex and BMI.

Ethical consideration: During data collection for the current study the ethical principles were followed. The protocol of the present study was submitted to the Institutional Ethics Committee.

Permissions were also sought from Medical Superintendent of the hospital attached to our medical college.

Intraoperative measurement: Procedure was performed under tourniquet after exsanguinations for complete hemostasis and clear surgical field. Small oblique skin incision inferomedial to tibial tuberosity was used. Infra patellar branch of saphenous nerve which is closely related to insertion of tendons was safeguarded from being severed. Sartorius fascia was incised along the line of inserting tendons to expose Semitendinosus and Gracilis tendons. These tendons are identified separately up to their insertions, any inter tendinous adhesions present along these tendons are released.

Semitendinosus tendon is isolated and detached from its tibial insertion and held with a non-absorbable suture. Before passing the tendon through the graft harvester all the tendinous extensions (vincula) running into the gastrocnemius fascia are released which improves the excursion of the tendon. This would also prevent diversion of the course of tendon stripper and avoid premature division of the tendon. Subsequently the graft is harvested and prepared.

Muscle tissue and fat attached is cleared off from the harvested graft and tendon length is measured over graft preparation stand. Tendon length is measured from the margin of the tendon detached at its tibial insertion site to the ends of flattened (aponeurotic) tendinous strand. If the length of the tendon is adequate (28 cm or more) then tendon is quadrupled and proceeded with graft preparations. If the length of the harvested tendon is not adequate enough then the gracilis tendon is harvested for augmentation. Quadrupled tendon diameter measured using cylindrical sizing tubes calibrated to 0.5 mm increments starting from 6mm to 12 mm.the smallest diameter through which graft could pass through is considered as the graft diameter. The standard tendon harvesting and graft measuring technique as mentioned above was followed for all the patients and was done by the same surgeon. Anthropometric data was also measured by a single researcher. Gracilis morphometry was not included for the study. In cases with short semitendinosus, tendon is quadrupled and diameter was measured for the study purpose. In this study the tendon size as a graft and its relation to patient's anthropometric values are looked into. Type of procedure or the results of reconstruction procedures were not considered. Confidentiality of the patient details was maintained.

Statistical analysis of data collected was entered and analyzed using Minitab ® 17.1.0., © 2013 Minitab Inc. All data distribution analysis was done through Shapiro-Wilk test. After testing normality, an appropriate parametric or non-parametric test was considered. Data were evaluated using conventional statistical tests and multivariable analysis as described. Pearson's correlation test was used to see the correlation between graft size and anthropometric parameters.

Results

The present study includes a total of 68 participants (57 Male and 11 Female). Mean age of the participants was 28.53 yrs (±7.820), mean height was 1.674m (±0.079), mean weight 72.65 kgs (±10.49), mean BMI was 25.98kg/m^2 (±3.813), mean length of semitendinosus (ST) was 27.77cm (±2.008) and mean quadrupled graft diameter was 7.838 mm (±0.444) as shown in Table 1.

As shown in Figure 1. Pearson's correlation test was applied to assess the relation between height of the participant and length of ST tendons and a strong correlation between the two variables was observed r=0.755 (p<0.001).

To evaluate the correlation between height and diameter of the quadrupled tendon Pearson's correlation test was applied and a p value of 0.005 and r= 0.357 was noted (Figure 2). There was a weak correlation between two but statistically significant.

The relationship between length and diameter of ST tendon with remaining parameters is shown in Table 2. Weight and BMI were moderate indicators of diameter of tendon in both the sexes.

Multivariable analysis with linear regression was applied to assess the influence of various independent variables such as age, weight, gender and height on the size of the tendon. In the final model, we included age, height, weight and sex (Table 3). Model fit was adequate with R^2 59.9% (adjusted) and Variance inflation factors within 1 to 3, for all predictors indicating no multi-co linearity between them. The association between the tendon length and the predictors is statistically significant with ≤ α of 0.05 (adjusted *P*, *P*/number of predictors in the model). Height of patient was able to predict the length of tendon in our study. The diameter was not included in final model

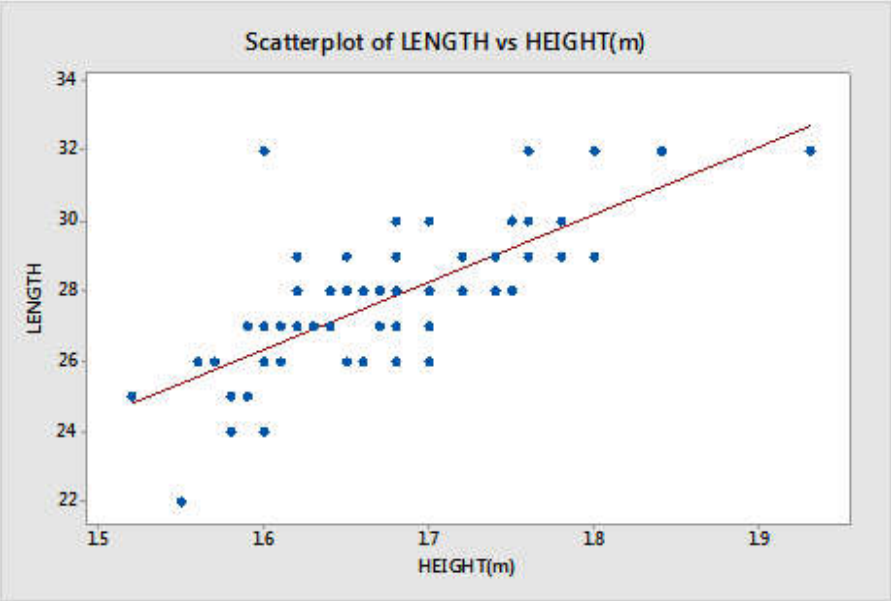

Fig. 1: Scatter plot showing correlation between height and length of semitendinosus tendon.

Pearson's correlation testing demonstrating the relationship between height (m) of the participant and length (cm) of the tendon. The correlation coefficient, r = 0.755, and p-Value < 0.001.

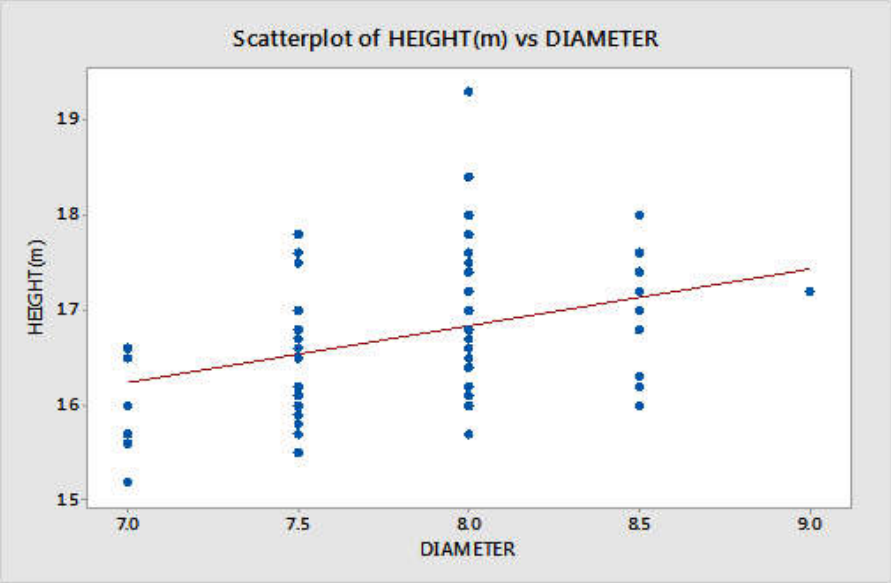

Fig. 2: Scatter plot showing correlation between height and diameter of quadrupled tendon.

Pearson's correlation testing demonstrating the relationship between height (m) and diameter (mm) of quadrupled graft. The correlation coefficient, r = 0.357, and p = 0.005.

Table 1: Discriptive variables with tendon dimensions. (n=68)

Variables	Mean	Standard Deviation	Median	Maximum	Minimum
Age(years)	28.53	7.820	27.50	66	16
Height(m)	1.674	0.079	01.67	1.93	1.52
Weight(kgs)	72.65	10.49	72.00	110	56
BMI(kg/m2)	25.98	3.813	25.46	41.40	19.26
Length of ST(cms)	27.77	2.008	28.00	32	22
Graft Diameter(mm)	07.838	0.444	08.00	9	7

m – Meter, kgs- kilograms, BMI- body mass index, ST- semitendinosus, mm- milimeter

Table 2: Pearson's correlation between graft length and diameter with various anthropometric parameters

Anthropometric measurements	p	r
Length and diameter	0.001	0.400
BMI and diameter	0.908	0.014
BMI and length	0.168	0.169
Height and diameter	0.05	0.337
Height and length	0.00	0.755
Weight and diameter	0.090	0.207
Weight and length	0.007	0.32
Age and length	0.238	0.145
Age and diameter	0.461	0.091

BMI- body mass index

Table 3: Regression analysis for predictors for Semitendinosus tendon length

Predictors	Coef	SE coef	p value	VIF
Constant	-2.71	3.6	0.454	
Age(years)	0.027	0.022	0.228	1.23
Height(m)	15.9	2.33	0.000	1.4
Weight(kgs)	0.027	0.017	0.117	1.26
Gender	1.4	0.495	0.006	1.4

Coef-coefficient; SE- standard error; VIF-variance inflation factor. The linear regression model included age, sex, height and weight as predictors. R^2 and adjusted R^2 were 62.32% and 59.9% respectively for linear regression model. VIF were 1-3.

because of poor fit. This was later translated into following equations which may help in predictions. The equations are as follows for either sex and may be useful in calculating the lengths of tendon necessary in preoperative period.

Regression Equations for length -

length = -1.31 + 0.0268 Age (yrs) + 0.0265 Weight (kgs) + 15.90 Height (m)

Discussion

In our study which included 68 subjects it was observed that there was a significant correlation between height of the individual and the length of semitendinosus graft. Fifty five percent of subjects had adequate length of tendon. In female sex only 18% had adequate length of tendon. Quadrupled diameter of tendon was adequate in all the subjects, indicating that tendon length has no relation to its diameter. Weight and BMI were moderate indicators of diameter or thickness of tendon. All those with adequate tendon length were of the average height of 172 cms which is above the universal average height of young people (170.6 cm) aged between 20-30 yrs [13].

Similar to the observations made in our study, S Challa and J satyaprasad concluded that height of an individual correlates with the length of the hamstring. In contrast to our study, they were able to correlate height of the individual with the graft diameter. But found no correlation of graft size with BMI, age, gender and weight.

Height and weight of the patients correlated with the graft length in a comparable study done by Papastergiou G. Stergios et al. [14]. However, they did not find any statistically significant predictors of graft diameter. In a cadaveric study conducted by Pichler et al, the length of the semitendinosus tendon was found to correlate with femur length [15].

Ravi Gupta in his study on 123 patients had the average length of ST tendon of 312.32±34.61 mm and observed strong correlation with leg length. He proposed a equation to predict the length and thickness [16]. Study conducted by Chiang et al using 100 patients showed that tendon lengths correlated with anthropometric measurements and also concluded that Caucasians had longer tendon lengths when compared to Chinese population [17]. Similarly, study made on forty cadavers in Kenya by brianbundi et al. found to have average semitendinosus tendon length of 29.80±3.59 cm and concluded to have longer semitendinosus tendon when compared to studies from Chinese, Austrian and Indian populations [18].

Anthropometric parameters were correlated to graft diameter in other similar studies.

Pinhiero et al. conducted a study on eighty

patients and observed that there was correlation between weight, height, gender, thigh length and size with graft diameter [19].

The study conducted in north Indian population by Asif et al developed an equation for preoperative prediction of graft diameter in Indian population after finding a strong correlation between thigh circumference and height of individual with graft diameter [2]. Predictors for the length of the graft were not assessed in contrast to our study.

Ma et al noted that height was specific predictor of hamstring diameter in males [20]. In a study conducted by Tuman et al in American population Quadrupled graft diameter was related to height, mass, age, gender but not BMI. Height was considered as a sole variable in an equation predicted by Tuman et al and Treme et al for expected graft diameter [21,22]. Goyal et al utilized preoperative assessment equation formulated by Tuman et al in Indian population and observed the existence of ethnic variation [23]. Similar observations were made in other identical studies [17,24].

Limitations in our study are unequal numbers between sexes, sample size of our study is not sufficient in case of females. Sample population includes only those to whom surgical reconstructive procedures were advised, that includes age restrictions.

Conclusion

Semitendinosus tendon length is predictable as the study shows strong relation to height of the individual. Diameter or the thickness is moderately related to BMI. Thickness of tendon in our local population is adequate. As a solitary graft length of the tendon is the important feature and is not related to thickness according to our study. We believe that these are very useful findings for a surgeon planning for reconstruction of cruciate ligaments.

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Study of Length of Lateral Lamella of the Cribriform Plate

Deepa G[1], Shrikrishna BH[2]

Abstract

Introduction: The roof of ethmoid (fovea ethmoidalis) separates the ethmoidal cells from the anterior cranial fossa. Medially the fovea attaches to the lateral lamella of the cribriform plate (LLCP), which is the thinnest bone of the skull base. Hence, it is at a high risk of getting damaged during endoscopic sinus surgery. *Objective:* To evaluate the height of lateral lamella of cribriform plate using the computed tomographic (CT) images of patients. *Materials and Methods:* Coronal views of 80 computed tomography films of paranasal sinus region were studied. Coronal sections at the level of centre of infra-orbital foramina were taken as the reference slide. The height of the lateral lamella of the cribriform plate was measured and then classified according to Keros classification. *Results:* The CT scans from 80 patients were analyzed. The median height of the LLCP in 160 sides was 3.3 mm (SD+1.63). The LLCP height was 0 to 3.9 mm in 122 sides, 4.0 to 7.0 mm in 33 sides, and greater than 7.0m min 5 sides. The lateral lamella of the cribriform plate averaged 3.47 mm (SD +1.68) in height on the right side and 3.08 mm (SD+1.59) on the left. The LLCP height was greater on the right side in 55 patients, greater on the left side in 19 and equal on both sides in 6 patients. The difference between sides was 0 to 1.9 mm in 78 patients, 2.0 to 3.9 mm in 1 patient, and greater than 4.0 mm in 1 patient. Student t test was used to compare the mean height of LLCP on each side. t value = 1.519. The difference of the height was not significant when right and left sides were compared (p = 0.131). *Conclusion:* In our study, the median height of the LLCP was 3.3 mm. Mean height of the LLCP on right side (3.47) was more than mean height of the LLCP on left side (3.08). But the difference was not statistically significant. However, variations do exist between right and left sides. A surgeon must take proper caution while operating in the area of lateral lamella of cribriform plate to prevent unintentional skull base injury and cerebrospinal fluid leak. A proper pre-operative evaluation of computed tomography of para nasal sinuses is essential to avoid life threatening complications during endoscopic sinus surgery.

Keywords: Computed tomography; lateral lamella; cribriform plate; olfactory fossa; endoscopic sinus surgery.

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Introduction

Anatomical variations are common in the sinonasal region. These anatomical variations frequently contribute to sinusitis. Pre-operative Computed Tomography (CT) scan not only reveals the presence but also the extent of sinus disease as well as anatomical variations, thus providing the surgeon with invaluable guidance [1]. Iatrogenic complications during sinus surgery are frequent if the sinonasal anatomic variations, especially of ethmoid roof are not studied pre-operatively. The depth of the olfactory fossa is determined by the height of the lateral lamella of the cribriform plate (LLCP). Keros has classified the ethmoid roof into 3 types based on the distance between the cribriform plate and the lateral lamella: type 1, 1-3 mm; type 2, 4-7 mm; and type 3, 8-16 mm [2]. The type 3 ethmoid roof is weak, and the cribriform plate of the ethmoid skull base, which forms a large part of the roof, is less protected than in the other

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Keros types. Therefore, type 3 patients are more susceptible to iatrogenic complications [3].

We studied this crucial anatomy of the ethmoid roof using computed tomography scans of paranasal sinus area and analysed the asymmetry of lateral lamella of the cribriform plate (LLCP).

Materials and Methods

Our study is an observational hospital based prospective study conducted during June 2015 to May 2017. Ethical clearance was received from our institutional ethical clearance committee. Our study group consisted of adult patients who underwent CT scan of paranasal sinus region in the oto-rhino-laryngology department at Navodaya Medical College Hospital, Raichur. Patients with nasal polyp or tumour, severe paranasal sinusitis, any prior operation on the paranasal sinuses, congenital abnormalities of the face and age less than 18 years were excluded from our study. After this exclusion, coronal views of 80 computed tomography films of paranasal sinus region were pooled and studied. A direct coronal positioning was done with the patient prone with the chin extended (neck hyper extended). The slice thickness was 1 mm. Bone algorithm was used for acquisition and the scans were interpreted in bone window. Coronal sections at the level of centre of infra-orbital foramina were taken as the reference slide. A specialized computer software ''picture archiving and communication system'' (PACS) was used for morphological evaluation of the CT scans. This software provided tools to establish the necessary distance measurements. The height of the lateral lamella of the cribriform plate was measured and then classified according to Keros classification. The data was tabulated in an excel spreadsheet which was then exported to SPSS Ver. 20.0 for analysis.

Results

The CT scans from 80 patients were analyzed. Few images are shown in figures 1, 2 and 3. The median height of the LLCP in 160 sides was 3.3 mm (SD±1.63). The LLCP height was 0 to 3.9 mm (Keros type 1) in 122 sides (76.25%), 4.0 to 7.0 mm (Keros type 2) in 33 sides (20.63%) and greater than 7.0 mm (Keros type 3) in 5 sides (3.12%). The lateral lamella of the cribriform plate averaged 3.47 mm (SD±1.68) in height on the right side and 3.08 mm (SD±1.59) on the left. The LLCP height was greater on the right side in 55 patients (68.75%), greater on the left side in 19 (23.75%) and equal on both sides in 6 patients (7.5%). The difference between sides was 0 to 1.9 mm in 78 patients, 2.0 to 3.9 mm in 1 patient, and greater than 4.0 mm in 1 patient. Student t test was used to compare the mean height of LLCP on each side. t value = 1.519. The difference of the height was not significant when right and left sides were compared (p = 0.131).

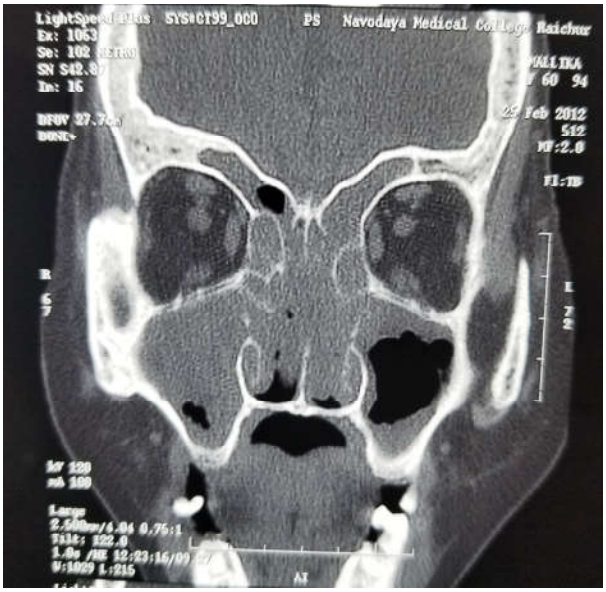

Fig. 1: Bilateral Short Lateral Lamellae

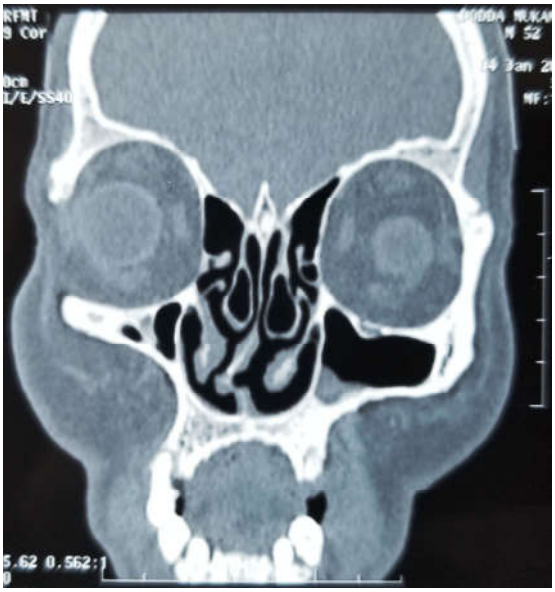

Fig. 2: Right and Left Lateral Lamellae Equal and Medium in Length

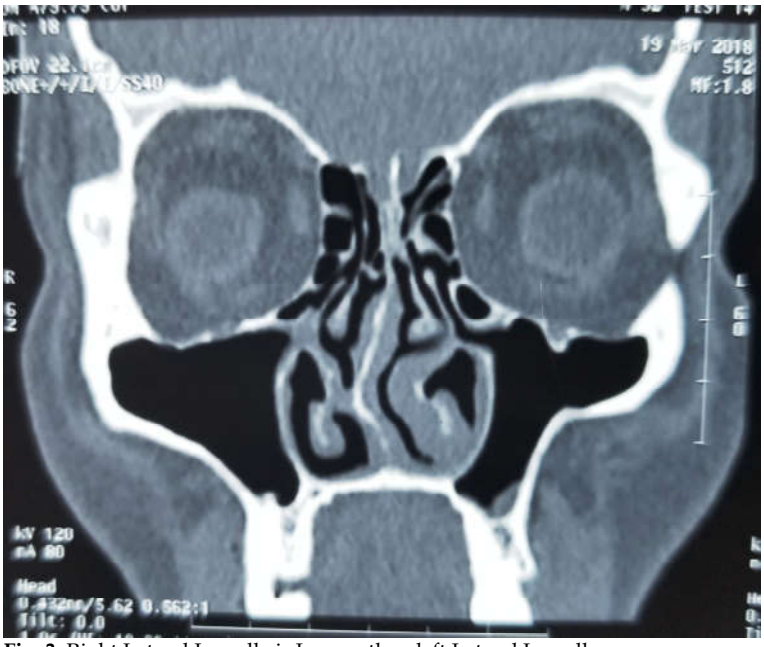

Fig. 3: Right Lateral Lamella is Longer than left Lateral Lamella.

Discussion

Endoscopic sinus surgery is a frequently performed procedure for refractory sinusitis. The advent of rigid telescopes and the computed tomography has reduced the risks during endoscopic sinus surgery. The endoscope brings better vision and exposure with lesser bleeding - together leading to better results. An optimal preoperative evaluation including CT scan and a thorough knowledge of paranasal anatomy is paramount in a successful endoscopic sinus surgery. But, a proper analysis of the ethmoid roof, more so of the height of lateral lamella of the cribriform plate will reduce iatrogenic complications like cerebro-spinal fluid rhinorrheoa, damage to orbital structures, bleeding and meningitis. The paranasal sinus region exhibits varied anatomical variations, the knowledge of which is essential for any endoscopic sinus surgeon. One of these important anatomical variations is that of the height of lateral lamella of cribriform plate. Keros has classified the ethmoid roof into 3 types based on the height of lateral lamella of cribriform plate: type 1, 1-3 mm; type 2, 4-7 mm; and type 3, 8-16 mm [2]. The type 3 ethmoid roof is weak, and the cribriform plate of the ethmoid skull base, which forms a large part of the roof, is less protected than in the other Keros types. Therefore, type 3 patients are more susceptible to iatrogenic complications during endoscopic sinus surgeries [3].

In our study, the LLCP height was 0 to 3.9 mm (Keros type 1) in 122 sides (76.25%), 4.0 to 7.0 mm (Keros type 2) in 33 sides (20.63%) and greater than 7.0 mm (Keros type 3) in 5 sides (3.12%). In a similar study by Bask et al., 9% of patients had Keros type 2, 53% had type 3, and 38% had type 1 [4]. A similar study by Souza et al. revealed 26.2% patients with type 1, 73.3% patients with type 2, and 0.5% patients with type 3 [5]. A similar study by Gluer et al. revealed 26% patients with type 1, 66 % patients with type 2, and 8% patients with type 3 [6]. A similar study by Anderhuber et al. revealed 14.2% patients with type 1, 70.6% patients with type 2, and 15.2% patients with type 3 [7]. A similar study by Nitinavakarn et al. revealed 11.9% patients with type 1, 68.8% patients with type 2, and 19.3% patients with type 3 [8]. A similar study by Alazzawi et al. revealed 80% patients with type 1, 20% patients with type 2, and none with type 3 [9]. A similar study by Erdem et al. revealed 8.1% patients with type 1, 59.6% patients with type 2, and 32.3% patients with type 3 [10]. A similar study by Ali et al. revealed 20% patients with type 1, 78.7% patients with type 2, and 1.3% patients with type 3 [11]. A similar study by Jang et al. revealed 30.5% patients with type 1, 69.5% patients with type 2, and none with type 3 [12]. A similar study by Nouraei et al. revealed 92% patients with type 1, 7% patients with type 2, and 1% patients with type 3 [13]. A similar study by Solares et al. revealed 83% patients with type 1, 15% patients with type 2, and 2% patients with type 3 [14]. A similar study by Adeel et al. revealed 29.9% patients with type 1, 49.4% patients with type 2, and 20.8% patients with type 3 [15]. The reason for apparent differences in the LLCP height is difficult to determine. The cause

may be due to different methodologies used in the respective studies like cadaveric dissection, CT imaging etc.

Also important is the difference in the height of LLCP between right and left sides because, the possibility of injuring the skull base increases with increasing height of the LLCP. In our study, the lateral lamella of the cribriform plate averaged 3.47 mm (SD±1.68) in height on the right side and 3.08 mm (SD±1.59) on the left. The LLCP height was greater on the right side in 55 patients (68.75%), greater on the left side in 19 (23.75%) and equal on both sides in 6 patients (7.5%). The difference between sides was 0 to 1.9 mm in 78 patients, 2.0 to 3.9 mm in 1 patient, and greater than 4.0 mm in 1 patient. This finding is in accordance to the findings in the studies by Wormald [16] and Dessi P et al. [17], where in it was observed that the right fovea ethmoidalis is lower than the left in more cases. A pre-operative knowledge about this possible anatomical variation helps in preventing dreadful skull base injuries during endoscopic sinus surgeries.

The Keros type III is considered as the most vulnerable for iatrogenic lesion during frontoethmoidal surgery due to its long length of the lateral lamella. The area of the entry of AEA through the lateral lamella into the olfactory fossa is considered the thinnest and at risk of injury causing CSF leak [18,19]. In our study, Keros type III i.e. greater than 7.0 mm was noticed in 5 sides. These asymmetries in the anatomy of ethmoidal roof need to be kept in mind to prevent complications. These previous studies, together with the present one, should alert surgeons to the frequency of ethmoid roof asymmetry, which should be taken into consideration to avoid iatrogenic injury.

Conclusion

In our study, the median height of the LLCP was 3.3 mm. Mean height of the LLCP on right side (3.47) was more than mean height of the LLCP on left side (3.08). But the difference was not statistically significant. However, variations do exist between right and left sides. Endoscopic sinus surgery should be preceded by planning CT as intra-operative discovery of anatomical variations creates problems. A surgeon must take proper caution while operating in the area of lateral lamella of cribriform plate caution to prevent unintentional skull base injury and cerebrospinal fluid leak. A proper pre-operative evaluation of computed tomography of para nasal sinuses is essential to avoid life threatening complications during endoscopic sinus surgery.

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Study of Branching Pattern of Renal Artery and its Variations

Deepthi S[1], Suseelamma D[2], Upendra M[3]

Abstract

Introduction: Arterial supply of kidney comes from renal artery which are the branches of abdominal aorta. *Aim & objectives:* To study the variations of branching pattern of renal artery & abdominal aorta. *Material and methods:* In the present study 30 cadavers were studied during routine dissection from Ayaan institute of medical sciences & DR. VRK womens medical college, moinabad. For Dissection followed the Cunningham's manual volume-II. *Results & observation:* out of 60 renal arteries observed the two variations. Right renal artery gives right testicular artery, another variation on left side abdominal aorta gave accessory renal artery. *Conclusion:* Knowledge of arterial supply of kidney is important to urologist, vascular surgeons, nephrologists and radiologist.

Keywords: Renal artery; accessory renal artery; abdominal aorta; testicular artery.

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Introduction

Knowledge of morphology of renal artery, branches and its variations is important in renal transplantation, renal trauma surgery, radiological imaging and surgical treatment of aortic aneurysms. Variations of the branches of renal artery and their relations to surrounding structures are important in regards to intra-abdominal surgery [1].

Each kidney is supplied by renal artery which is a branch of abdominal aorta. Occasionally an accessory renal artery arising from the abdominal aorta which supplies upper or lower part of the kidney without passing through the hilum. An accessory renal artery is the precocious origin of segmental artery [2].

Development

As the kidneys ascends from pelvis to lumbar region, they are vascularised by a succession of transient aortic sprouts that arise at higher levels progressively. These arteries do not elongate to follow the ascending kidneys; instead they are degenerated and replaced by successive new arteries. The final pair of arteries forms in the upper lumbar region as the definitive renal arteries. Sometimes, the inferior pair of arteries is not degenerated and becomes an accessory lower pole artery.

The origin of intrarenal vasculature has not yet been completely understood. It was postulated that the renal vasculature derived exclusively from the branches of the aorta and other pre-existing extra renal vessels. However, there was evidence that the renal vessels may originate within the embryonic kidney from the vascular progenitor cells. It was also thought that both vasculogenesis and angiogenesis may play a role in the development of renal vasculature [3].

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Aim & Objectives

1. To expose the abdominal aorta and its branches.
2. To describe the variations of renal artery and its branches.

Material and methods

30 human cadavers were studied during routine dissection from Ayaan Institute of Medical Sciences, Dr. VRK Womens Medical College, Moinabad, Hyderabad.

Method

Dissection method

Procedure: As per cunningham's Manual of Practical Anatomy Volume -2, 15th edition (Thorax and Abdomen) the right and left kidneys and the surrounding tissues were removed en bloc with the adjacent part of the aorta cleared and studied [4,5].

Results & Observations

Dissected 30 cadavers, according Cunningham manual Volume-II. Out of 60 renal arteries. We were observed the two variations. Right renal artery gives right testicular artery, another variation on left side abdominal aorta gave accessory renal artery.

1. The accessory renal artery runs above the main renal artery, it enters the kidney through the hilum on left side. (Fig. 2)
2. Right renal artery close to abdominal aorta,it gave right testicular artery. (Fig. 3)

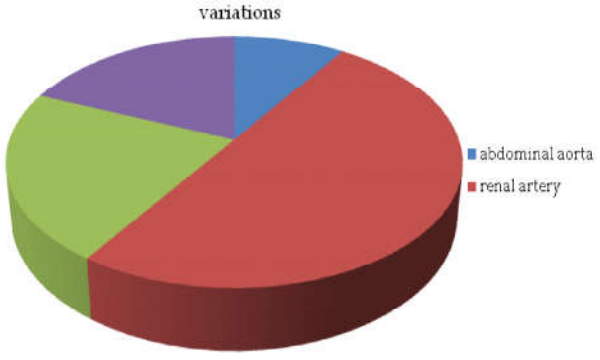

Fig. 1: Pie chart showing abdominal aorta branches

Table 1: Showing the variations of renal artery

S. No	Type of Variation	Right Side	Leftside
1	Accessory renal artery arose from the abdominal aorta (Fig.2)	Not found	observed
2	Testicular artery arose from the renal artery (Fig.1)	Observed	Not found

Fig. 2: showing renal artery (RA) gave testicular artery(TA) on right side

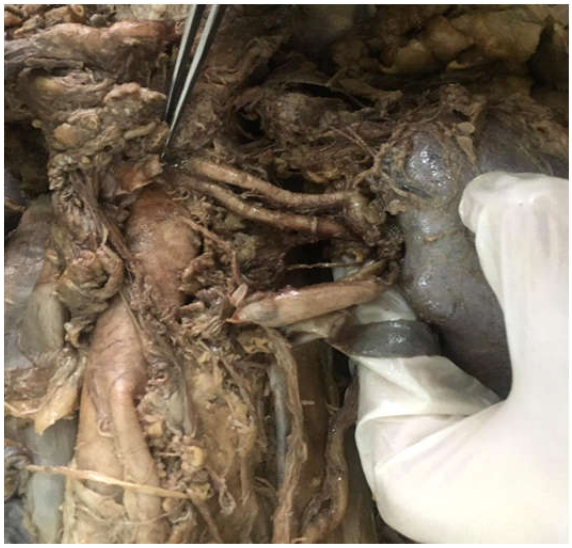

Fig. 3: showing accessory renal artery (ARA) arose from abdominal aorta (AA) on left side

Discussion

Ugar O et al. concluded that 98% of the patients, main renal artery originated between the upper margin of L_1 and the lower margin of L_2 vertebrae. Right main renal artery originated from the lower margin of the L_1 vertebra in 25%, from the level of the L_1-L_2 intervertebral disc in 23%, and from the upper margin of the L_2 vertebra in 20% of the patients. On the right side, 77% of ERA originated between the upper margin of L_1 and the lower margin of L_2 vertebrae, and 20% originated from the level of the L_1-L_2 intervertebral disc [6].

In present study renal artery arises from lower margin of L_1 vertebrae in all specimens.

According to vanitha Gupta right kidney was supplied by three renal arteries and was drained by two renal veins. The upper renal artery arose at the level just below the superior mesenteric artery (SMA), before going to the kidney it divided into three branches in a looped pattern. The middle renal artery arose just 1 cm below the first. The lower renal artery was seen arising from the aorta just below the origin of inferior mesenteric artery (IMA) [7].

In our study right kidney was supplied two renal arteries one is main renal artery and another one accessory renal artery both were arose from lateral aspect of abdominal aorta.

Jigan A. K et al. concluded Accessory renal artery arose from abdominal aorta it enters the upper pole of the kidney without passing through the hilum in 2 specimens out of 30 renal arteries [8].

In our study found one accessory renal artery arose from abdominal aorta it enters the kidney through the hilum.

Budhiraja V observed single renal artery in 18/42 (42.9%) on right side and 20/42 (47.6%) on left side, originating from abdominal aorta. Multiple renal arteries originating from abdominal aorta were present in 24/42 (57.1%) cases on right side and 22/42 (52.4%) cases on left side, these arteries include double hilar arteries, three hilar arteries (THA), one hilar and one superior polar artery (SPA), one hilar and one Inferior polar artery (IPA) [9].

In this study renal artery gave two variations out of 60 renal arteries. one variation was accessory renal artery arose from abdominal aorta. Another variation was renal artery gave testicular artery on right artery.

Syamala et al. found the two renal arteries entering to the right kidney through the hilum. The accessory renal artery is above the renal artery. Left kidney had single renal artery. Normally extra renal arteries runs either above (or) below the main renal artery.

In our study findings were similar to above study.

Kumareswaren M et al. studied and concluded that 51% of kidney donors showed variation in the renal artery. Out of 51% variations 38 individuals had accessory renal artery and 13 individuals had early division of renal artery. The distribution of accessory renal artery was equal on both sides (13% on right and left) and 12% of individuals had accessory renal artery on both sides. Out of 13% earlier divisions, 5% was on right side, 7% was on left side and 1% was on both sides [11].

In our study two variations were observed in out of 30 cadavers. Accessory (hilar) renal artery arises from the ventral part of abdominal aorta on left side and right renal artery gives testicular artery.

Cases.C.et.al studied in 86 renal arteries. They established the five types of classification. Type-A Aortic hilar artery, Type-B; hilar upper polar artery, Type-C-aortic upper polar artery, Type. D-aortic lower polar artery, Type-E hilar lower polar artery [12].

In my study we found type-B classification of renal artery.

Conclusion

It is important to have the knowledge about the variations of renal arteries which give awareness and also help in minimising the hazards like bleeding or ligation of the artery during various surgical procedures. As the incidence of renal arterial variation is up to 30%. It is better to have the knowledge about the anatomical consideration of renal arteries.

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Original Article

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Study of Eustachian Tube-Reid's Plane Angles in HRCT Temporal Bone of Patients with Chronic Otitis Media

Deepa G[1], Shrikrishna BH[2]

Abstract

Introduction: Chronic Otitis media is still a serious disease all around the world. The disturbance in the ventilation of the middle ear appears to play a major role in etiology of chronic otitis media especially in formation of cholesteatoma. The angle between the Reid's plane and the eustachian tube (ET) decides the ventilating function of the eustachian tube. This study aimed to compare the mean of Eustachian tube- Reid's plane angle in Chronic Suppurative Otitis Media (CSOM) patient with and without cholesteatoma. *Objective:* To compare the mean of Eustachian tube - Reid's plane angle in Chronic Suppurative Otitis Media (CSOM) patients with and without cholesteatoma using high resolution computed tomography (HRCT) Temporal bone. *Materials and Methods:* This is a retrospective study of 2 patient groups. First group consisted of 50 patients with Chronic Otitis media with cholesteatoma and the second group consisted of 50 patients without cholesteatoma. The presence or absence of cholesteatoma was decided based on records of intra-operative findings and HRCT temporal bone reports. The Reid's plane- ET angle was measured using High Resolution Computed Tomography (HRCT) of the temporal bones in both groups and compared. *Results:* The mean Reid's plane-ET angle was 27.20 degrees in the first group with cholesteatoma with a standard deviation of +1.92. The mean Reid's plane-ET angle was 31.69 degrees in the second group without cholesteatoma with a standard deviation of +2.25. Independent t test (student t test) used for analysis. t value was 10.709. p value was <0.0001. The findings were statistically significant. There was highly significant difference in mean Eustachian tube- Reid's plane angle between group 2 and group 1 (it was higher among group 2 compared to group 1). *Conclusion:* The Reid's plane-ET angle has a major role in assessing the eustachian tube dysfunction. A reduced Reid's plane-ET angle noted in a pre-operative tomographic assessment gives clues about the possibility of cholesteatoma in chronic otitis media. This assessment will help the ear surgeon to plan surgery accordingly for better post-operative results.

Keywords: otitis media; cholesteatoma; eustachian tube; middle ear ventilation; computed tomography.

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Introduction

Chronic suppurative otitis media (CSOM) is a major health burden throughout the world. It is a long standing infection of the middle ear cleft associated with tympanic membrane perforation and ear discharge. The infection may be associated with cholesteatoma or not associated with cholesteatoma. The cholesteatomatous type of CSOM is unsafe as it is associated with serious intra-temporal and intra-cranial complications.

Factors which play role in the occurrence of CSOM are genetic pre-disposition, environmental factors and craniofacial anatomy. The size of the mastoid and Eustachian tube are cranio-facial anatomy which related in the occurrence of the CSOM disease. Middle ear ventilation, drainage, and protection of the middle ear to pathogens are major functions of the eustachian tube. There are many studies on the function of Eustachian

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tube. Dysfunction of the eustachian tube leads to poor ventilation of the middle ear cavity leading to formation of retraction pocket and cholesteatoma [1]. Aksoy et al. has observed in their study that a more horizontal Eustachian tube angle will cause eustachian tube dysfunction and impaired clearance in the middle ear. In their study, there was a significant relationship between lower eustachian tube angle and CSOM with cholesteatoma [2]. However, the role of the Eustachian tube angle and the relationship with the occurrence of CSOM has not been widely studied [3]. Research on the anatomy of eustachian tubes involving radiology is still less. Takasaki K et al. have shown in their study how one can measure the angle and length of the eustachian tube on computed tomography using the multiplanar reconstruction technique. By using multiplanar reconstruction techniques, the image can be adjusted as desired by changing the angle of the plane every 0.5 degrees and changing the station every 1 millimetre. Angle of the ET is the angle of a straight line from the pharyngeal orifice to the tympanic orifice of the ET against Reid's standard plane, which is defined as the plane connecting the infraorbital margins with the upper margins of the external auditory meatus [4].

The purpose of our study is to measure the eustachian tube-Reid's plane angles in patients with CSOM with or without cholesteatoma using HRCT temporal bone and compare the findings.

Materials and Methods

Our study is an observational; hospital based retrospective study conducted during June 2015 to May 2017. Ethical clearance was received from our institutional ethical clearance committee. Our study consisted of patients of CSOM who underwent surgeries in the department of ENT at Navodaya Medical College Hospital, Raichur during the above mentioned period. Paediatric patients of age less than 8 years and those showing a damaged temporal bone on tomography were excluded from the study. The patients were divided into 2 groups. First group consisted of 50 patients with CSOM with cholesteatoma and the second group consisted of 50 CSOM patients without cholesteatoma. The presence or absence of cholesteatoma was decided based on records of intra-operative findings and HRCT temporal bone reports. A multi-slice CT scan was used in the study with 1 mm of slice thickness. The horizontal plane, crossing bilateral inferior orbital wall and the bilateral upper wall of the external ear canal known as "Reid horizontal plane," is selected. The orifices of eustachian tubes can be seen in the same section by using multiplanar reconstruction technique in the coronal images. Pharyngeal and tympanic orifices of the eustachian tubes were demonstrated exactly at the same section. This direction was determined as the line of the eustachian tube. The angle was measured between the horizontal plane and this line. The data collected was tabulated and statistically analysed. Statistical significance between the two groups was calculated by paired t-test (SPSS software). p value < 0.05 was considered to be statistically significant.

Results

The mean Reid's plane-ET angle was 27.20 degrees in the first group with cholesteatoma with a standard deviation of ±1.92. The mean Reid's plane-ET angle was 31.69 degrees in the second group without cholesteatoma with a standard deviation of ±2.25. Independent t test (student t test) used for analysis. t value was 10.709. p value was <0.0001. The findings were statistically significant. There was highly significant difference in mean Eustachian tube-Reid's plane angle between group 2 and group 1 (it was higher among group 2 without cholesteatoma compared to group 1 with cholesteatoma).

Discussion

The middle ear and mastoid space is ventilated by a properly functioning eustachian tube. The Reid's plane-ET angle has a role in proper functioning of the eustachian tube. The more horizontal angle of the Eustachian tube causes eustachian tube dysfunction and leads to poor ventilation of the middle ear cavity leading to otitis media. Children are more prone for otitis media compared to adults due to their more horizontally placed eustachian tube. In adults, a horizontal orientation of the eustachian tube will lead to retraction pockets in the tympanic membrane which is a precursor of cholesteatoma.

The supporters of the genetic theory of the temporal bone pneumatisation claim that the temporal bone pneumatisation is genetically determined. On the other hand, the supporters of the environmental theory of the temporal bone pneumatisation claim that the temporal bone pneumatisation is reduced due to chronic otitis media which in turn is caused by environmental factors such as frequent upper respiratory tract infections, poor living conditions and smoking. The variation in the ET angles can affect the middle ear and mastoid pneumatisation secondary to poor ventilation through ET [4].

Our study proves that lower Reid's plane-ET angle is associated with cholesteatoma. The difference brings to mind that the idea may be a factor in combination with other factors in the development of cholesteatoma in these patients. A similar finding was noticed by Aksoy et.al, where in there was a significant relationship between lower eustachian tube angle and CSOM with cholesteatoma [2]. Takasaki et al. detected the eustachian tube angles in Reid plane $27.3^0 \pm 2^0$ for the right ear, $27.3^0 \pm 2.8^0$ for the left ear in the normal adult population. These angles of the children were found significantly lower (for the right ear $20.4^0 \pm 3.5^0$, for the left ear $21.2^0 \pm 4.8^0$ in the children with effusion and serous otitis media; the angles in the children with otitis media without effusion were $19.9^0 \pm 3^0$ right, left $20.0^0 \pm 3.6^0$, $p < 0.01$) [4].

Eustachian tubal dysfunction leads to middle ear pathology. In an experiment, excision of some tensor veli palatini muscle fibres in the pterygoid hamulus in the palate caused negative pressure in the middle ear and accompanied by the occurrence of middle ear effusion. Total excision resulted in under-pressures in the middle ear followed by persistent middle ear effusion [5].

Eustachian tube is a complex and in-accessible structure [6]. However, if its functional status is ignored by the ear surgeon, it will lead to failure of tympanoplasty surgeries, retraction pockets post-operatively and recurrence of cholesteatoma. Thus, ET dysfunction is an important prognostic factor for the success in tympanoplasty [7]. If the Reid's plane-ET angle is known pre-operatively to be on lower sides, the ear surgeon can compensate for the apparent dysfunction of the eustachian tube by doing cartilage tympanoplasty to prevent retraction pockets in post-operative period. During cartilage tympanoplasty, the graft (temporalis fascia/ perichondrium) is be supported by single cartilage slice anteriorly. This offers extremely reliable method for reconstruction of tympanic membrane in cases of ET dysfunction [7]. In cases of severe ET dysfunction due to pre-tympanic segment narrowing, balloon tuboplasty of the pre-tympanic segment can be combined with tympanoplasty, resulting in significantly high graft take up rate and restoration of middle ear integrity [8,9].

Conclusion

Although CSOM with cholesteatoma is a multi-factorial disease, eustachian tube dysfunction has an important role to play in its etiology. The Reid's plane-ET angle has a major role in assessing the eustachian tube dysfunction. A reduced Reid's plane-ET angle noted in a pre-operative tomographic assessment gives clues about the possibility of cholesteatoma in chronic otitis media. This assessment will help the ear surgeon to plan surgery accordingly for better post-operative results.

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Original Article

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Morphology and Morphometric Study of Mastoid Process in Human Dry Skulls with its Clinical Implications

Hema N[1], Swetha B[2]

Abstract

Aim: To evaluate morphometric measurements of mastoid process in temporal bone and to determine their bilateral differences. *Introduction:* Mastoid process is conical projection of mastoid part of temporal bone. It is situated behind external acoustic meatus and is connected with occipital and parietal bone by occipito-mastoid and parieto-mastoid sutures. The junction of these sutures with lambdoid meet at asterion, which coincides with postero-lateral fontanelle. The external surface is rough and inner surface presents a notch and a groove. It presents mastoid foramen which transmits emissary veins. *Methods*: One hundred South Indian dry skulls of unknown sex and age were studied from the bone collection available at Anatomy department. The parameters of mastoid process like Shape, Breadth, Height, Surface area and Volume were determined. The absence of mastoid foramen was also noted. *Results*: We observed mainly 4 types of shapes of mastoid process in our study. Ovoid, Globular, Conical and Bifid. Ovoid shaped process in most cases and Bifid shape is seen least in our study. Breadth and Height of mastoid process are more on the right side when compared to left side. Surface area in cms and Volume was in cubic cm also showed to be slightly more on the right side. All the parameters showed right sided dominance. Mastoid foramina were absent in 6 mastoid process. 3 on left side and 3 on right side.

Keywords: Mastoid process; Mastoid foramen; temporal bone; asterion.

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Introduction

Mastoid is the posterior region of temporal bone. It has an outer surface roughened by the attachments of occipital part of occipital frontalis and auricularis posterior. It projects down as conical mastoid process in the posteroinferior region of the temporal bone. Sternocleidomastoid, Splenius Capitis and Longissimus Capitis are attached to lateral surface. There is deep mastoid notch on the medial aspect to which posterior belly of digastric is attached. The borders are serrated for articulation with neighbouring bones. The internal surface bears a sulcus which is separated from mastoid air cells by a thin lamina [1]. Mastoid foramen is present in posterior part of mastoid temporal bone. It may be absent in few and when present, it transmits an emissary vein which communicate sigmoid sinus with post auricular vein or occipital vein and a small meningeal branch of occipital artery [2]. Generally morphological features of mastoid process are described as larger, heavier in males and smaller, more pointed in females [3].

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Materials and Methods

One hundred South Indian dry skulls of unknown sex and age were studied from the bone

collection available at Anatomy departments of Mysore Medical college, ESICMC and PGIMSR, Rajajinagar and BGS Global Institute of Medical Sciences, Bangalore. The following parameters of mastoid process were determined:

1. Shapes of the mastoid process were recorded on both the sides (Fig. 1).
2. MDB- Mastoid breadth/ width of the mastoid process was measured as a line extending from porion (point on the upper margin of external acoustic meatus) to asterion using divider and measuring scale.
3. MDH- Mastoid height / length measured from mastoidale (lowest point of mastoid process) to the intersection of the 1st line which is drawn from porion to asterion using divider and measuring scale (Fig. 2).
4. Surface area was recorded by using square reticule. The lateral surface of the mastoid process of the skull under study was superimposed on a transparent graph sheet which is called as square reticule.

The outline of mastoid process was drawn on square reticule from porion to asterion transversely and to mastoidale using sketch pen. The total number of squares within the outline was counted on the graph sheet which gave the surface area in square centimetres (sq cms) (Fig. 3).

The roughened area on the lateral surface of mastoid process was also marked and calculated

5. Volume was determined by water displacement method after preparing external mould of mastoid process using model clay (Fig. 4).

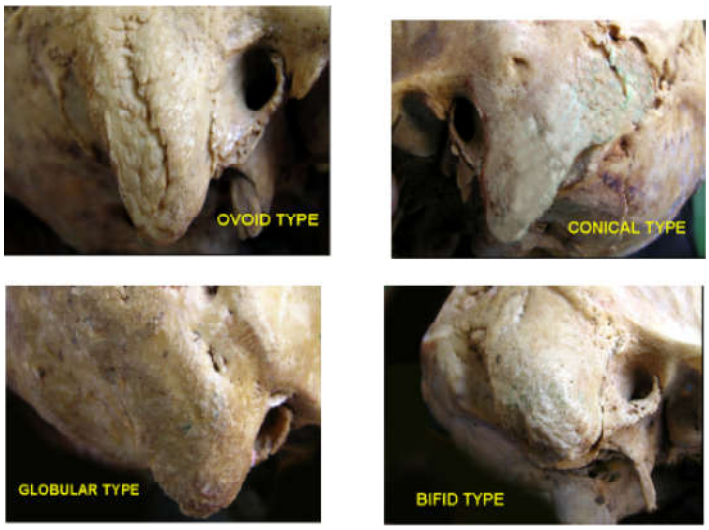


Fig. 1: Different shapes of mastoid process

Table 1: Percentage of Shapes of Mastoid Process on both the Sides

Shape	Right	Left
Ovoid	47	61
Conical	41	30
Globular	10	02
Bifid	02	07

Table 2: Measurement of Mastoid Breadth and Height (cms)

	Right			Left		
	Max	Min	Avg	Max	Min	Avg
Breadth	4.2	2.2	3.2	3.6	2.0	3.08
Height (length)	5.5	2.2	3.63	5.2	2.5	3.4

Table 3: Previous Studies on Mastoid Length by Various Authors

Author	Year	Population	Mean mastoid length in males	Mean mastoid length in females
Giles [22]	1963	Caucasian	28.06 mm	25.10 mm
Giles [22]	1963	Nigroes	30.32 mm	26.34 mm
Sumathi [8]	2010	North Indian	28.3 mm	23.18 mm
Das Gupta [23]	2012	South Indian	29.23 mm	22.44 mm

6. Absent mastoid foramen was noted.

Results

1. Different shapes of the mastoid process were observed on both the sides. (Fig. 1)

Ovoid, Conical, Globular and Bifid shapes were observed. Bifid shaped process was least observed. Percentage of shapes of mastoid process on both the sides is given in Table 1.

2. Breadth and Height (length) of mastoid process are more on the right side when compared to left side. (Table 2 and Fig. 2). Comparative results of the height of mastoid process with previous authors is shown in Table 3.
3. Total surface area and roughened area (which is due to the attachment of muscles) was marked and calculated which also showed that it is more on the right side. (Table 4 and Fig. 3)
4. Volume was measured in cubic cm which also showed to be slightly more on the right side. (Fig. 4).
5. Absent mastoid foramen was found in 6 specimens. (Fig. 5)

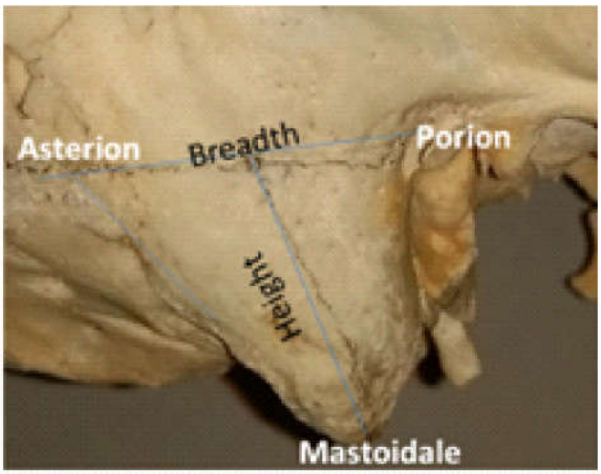


Fig. 2: Breadth and height of mastoid process

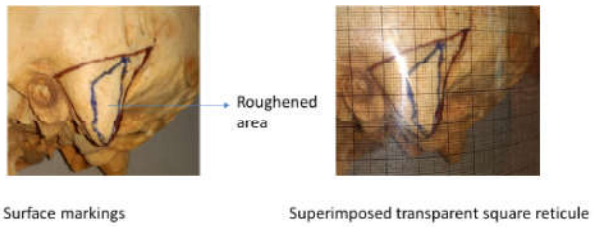


Fig. 3: Surface area

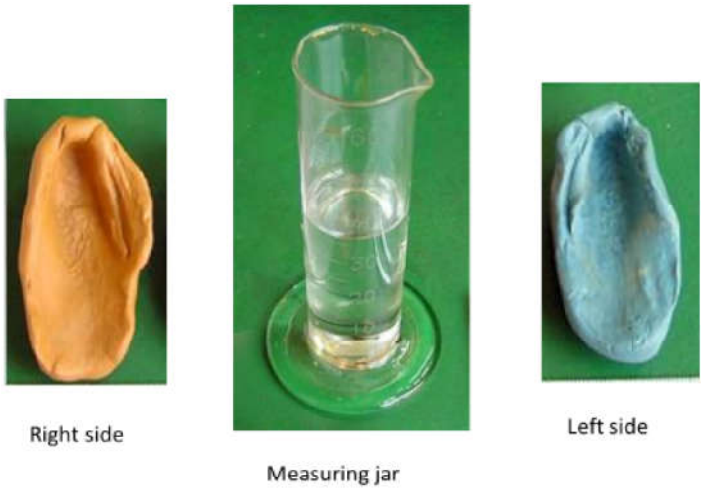


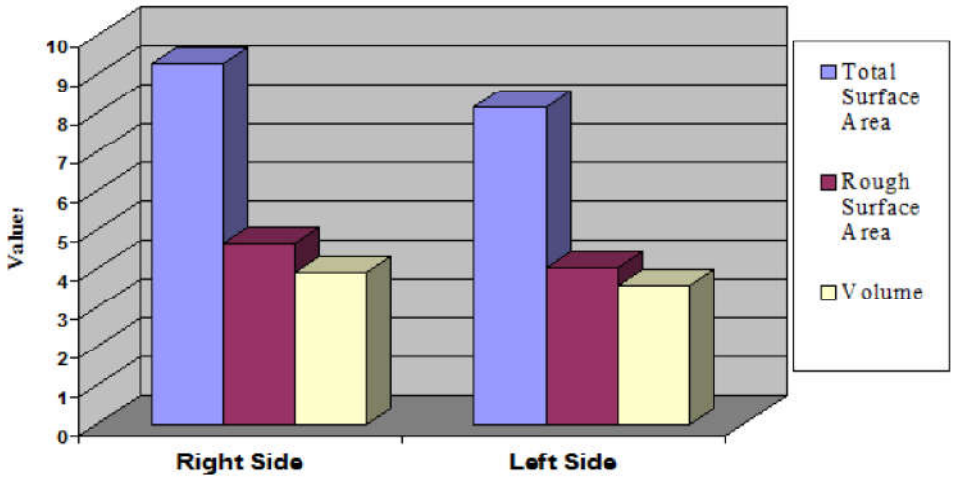
Fig. 4: Clay mould formation for estimation of volume of mastoid process

Table 4: Measurement of Surface Area (sq cm) and Volume (cubic cm)

	Right			Left		
	Max	**Min**	**Avg**	**Max**	**Min**	**Avg**
Total Surface Area	14	6	9.25	13	5	8.15
Rough Surface Area	7	2.5	4.65	6	2	4.03
Volume (CC)	6.2	2.0	3.90	6.0	1.0	3.58

Table 5: The Right Sided Dominance of the Parameters

Parameters	Right	Left
Mastoid breadth	3.2 cms	3.08 cms
Mastoid height	3.63 cms	3.47 cms
Total surface area	9.25 sq cms	8.15 sq cms
Rough surface area	4.65 sq cms	4.03 sq cms
Volume	3.9 cc	3.58 cc



Graph 1: Showing Right Sided Dominance of all the Parameters of Mastoidprocess

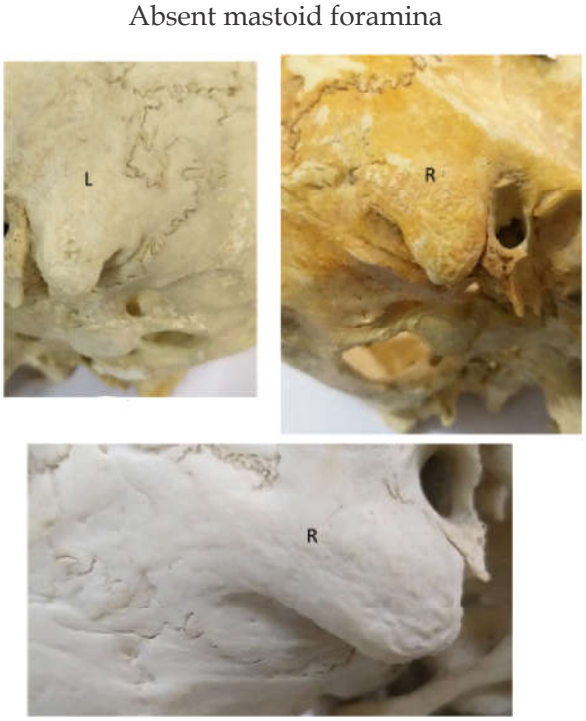


Fig. 5: Absent mastoid foramen

All the parameters showed right sided dominance. (Table 5 and Graph 1).

Mastoid foramina were absent in 6 mastoid process. 3 on left side and 3 on right side. (Fig. 5)

Fig. 6: Showing Enlarged foramen, deep notch and mastoid air cells

One skull had deep notch, an enlarged foramen was seen above external acoustic meatus, mastoid air cells was found to be extending up to the tip of mastoid process in one skull. (Fig. 6).

Discussion

Mastoid process is absent in new born and develops in 2nd year, when the child holds the head upright by the pull of sternocleidomastoid. The air cells gradually extend into it and by 4th year, they are well formed. Mastoid air cells may fill the mastoid process even to its tip. There are varieties of mastoid process: Pneumatic, Sclerotic and Mixed [2] In 20% of skulls, the mastoid process has no air cells at all [1]. More episodes of otitis media influences the mastoid pneumatization which further leads to

asymmetry [4]. When comparative evaluation done between the present and ancient populations, the otitis media is a common condition [5].

Many studies have been made on sex determination using anthropometric methods, but very few literatures were found on different shapes of mastoid process. Tomohito study concludes that it would not be safe to use mastoid process measurements for sex determination [6]. We have focused our study on the dimensions and shapes of Mastoid process. Descriptive statistics demonstrated pattern of social dimorphism in the mastoid region. The quantitative analysis provides greater consistency in identification than the qualitative features of the mastoid region [7]. This study was conducted to provide information on bilateral morphology and morphometric differences in mastoid process. We observed mainly 4 types of shapes of mastoid process in our study. Ovoid, Globular, Conical and Bifid. Ovoid shaped process was found in majority of skulls. (47 on right and 61 on left side). (Table 1). The observation on the shapes makes our study distinctive from the other available literature.

In our study, average measurement of height (length) showed 3.63 cms on right side when compared to left which has 3.47 cms. In previous studies, mastoid length was measured from a point on Frankfurt's plane to the tip of mastoid process and concluded that mastoid length is utilised to determine the sexes [8]. But Tomihito concluded that this method of measurement is not practical in anthropological and forensic context [6]. The study conducted by Hoshi in 1962 shows differences in mastoid process length and categorised into Male (M), neutral (N) and females (F). Length was found more in male in Japanese skulls [9]. Rajendrakumar et al studied mastoid length and their measurement was 2.4 to 3.7 cms which is correlating with our study [10]. A correlation coefficient was calculated which shows that the height of mastoid process is independent of other variables [11].

Surface area using square reticule was found to be 9.25 sq cm on right and 8.15 sq cm on left which was lesser when compared to studies done by Marco [12]. Temporal bone implants require storage space which is the cavity created by a canal wall up mastoidectomy [13].

An attempt is made to measure the volume of the mastoid process by water displacement method using clay modelling of mastoid process and found to be 3.9 cc on right side and 3.58 cc on left side which showed less values when compared to previous studies. CT measurement showed mastoid volume ranging from 5.5 to 72.4 cc [12]. Numerous studies showed that mastoid air cell system (MACS) volume is indirectly related to the predisposition of the middle ear to certain pathological conditions like otitis Media and cholesteatoma [14].

Recent studies shows the importance of surface area to volume ratio in gas exchange, as ratios appears to be somewhat constant [15]. The mastoid surface area and the volume measured in adult Brazilians follows a linear correlation [12].

Strong correlation between measurement of each side (bilateral symmetry) indicates significant genetic contribution. Weak correlation between these measurements (bilateral asymmetry) are suggestive of predominantly environmental contribution to the assessed structures [12]. The present study provide information on bilateral morphologic and morphometric differences on mastoid process, which showed strong correlation. (Table 5, Graph 1).

Mastoid foramen has a distinguished ancestry with a surgical important structure, primitive jugular vein [16]. We report absent mastoid foramen in 6 skulls. (3% incidence rate) whereas Boyd GI reported 31.9% absent mastoid foramen bilaterally and unilaterally absent in 33.7% [17]. Kim et al found 1.4% absent mastoid foramen bilaterally and 10.3% unilaterally [18]. Our study showed lesser percentage than the previous study.

An enlarged foramina on upper part of external acoustic meatus was observed. Ali Z Syed reported a case of an enlarged mastoid foramen on the right mastoid region of temporal bone by CT scan [19]. If this variant was not recognised would have potentially led to an incorrect diagnosis or caused iatrogenic life threatening bleeding during attempted surgery in the region of mastoid [20]. We found a deep notch on the posterior aspect of mastoid process. (Fig. 6) The success of mastoid operation, both simple and radical is so dependent on exposing the antrum that a definite knowledge of its location and parameters are of paramount importance [21].

Conclusion

An important finding from this study is regarding the right sided dominance of measurements on mastoid process and various mastoid shapes. The Anatomical knowledge about shape and surface area is important for the otologist during

implant surgeries. Mastoid surgeries should be carried out carefully to avoid damage to the surrounding structures.

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An Anthropometric Study of External Ear of Medical Students in India

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Abstract

Anthropometric refers to the measurements of living human body dimensions for the purpose of understanding human physical variation as it plays an important role in plastic surgery, prosthetics, so on for data collection. Many studies have defined human body parts and their proportion to each other morphometrically in human ear is the defining feature of the face and its structure shows the signs of age & sex. The human ear is divided in to external, middle and internal parts. Pinna & external acoustic meatus form the external ear. This study was carried out on 100 medical students age ranges from 17-26 years (44 females/56 males) studying in Ayaan institute of medical sciences, kanakamamidi, R.R. Dist. Telangana Subjects with evidence of congenital ear anomalies or previous ear surgeries excluded from the study. Following parameters of the external ear measured according to Mckinney et al. methodology. Anthropological measurement of external ear was found significantly different in male and females. Knowledge about the normal ear dimensions is important in the diagnosis of congenital malformations, syndromes and acquired deformities as well as planning of treatment & hearing instruments industry. This study provides the mean values of the different morphometric measurements of right & left ears in the medical students age ranging from 17-26 years in Indian region.

Keywords: External ear; Anthropometric measurements; Hearing instruments; Plastic surgery.

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Introduction

Anthropometric refers to the measurements of living human body dimensions for the purpose of understanding human physical variation as it plays an important role in plastic surgery, prosthetics, so on for data collection [1]. Many studies have defined human body parts and their proportion to each other morphometrically in human ear is the defining feature of the face and its structure shows the signs of age & sex. The human ear is divided in to external, middle and internal parts. Pinna & external acoustic meatus form the external ear. The lateral surface of the pinna is irregular concave, faces slightly forward and displays numerous eminences and depression [1]. The importance of anthropometric data was stressed by Abeysekera & Shahnavaz when they stated that a piece of equipment designed to fit 90% of the male united state population would fit about 90% of Germans, 80% of frenchmen, 65% of italians, 45% of japanese, 20% of thais and 10% of vietnamese [2]. Roebuck et al noted that anthropometric data vary considerably for individual within a family or a nation and between nation [3]. Since anthropometric data should be established for the user population as anthropometric data for India region is scant so, the aim of the present study is to provide the anthropometric data for the ear in Indian region.

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Materials and Methods

This study was carried out on 100 medical students age ranges from 17-26 years (44 females/56 males) studying in Ayaan institute of medical sciences, kanakamamidi, R.R. Dist. Telangana. Subjects with evidence of congenital ear anomalies or previous ear surgeries excluded from the study. Measurements of ear taken according to the landmarked points defines from Decarlo et al., [4] & Methodology was from Mckinney et al., [5] and Brucker et al., [6] The parameters measured when the head is in frankfort horizontal plane.

1. Total Ear Height (T.E.H)- Distance between the most inferior projection of the ear lobule to the most superior projection of the Helix (L-H).
2. Total Ear Width (T.E.W) – Distance between the most anterior and posterior points of the ear (A-P).
3. Lobular Height (L.H) – Distance between the most inferior end of lobule to the base of tragal notch (L-T).
4. Lobular width (L.W)- Transverse or horizontal width of the ear lobule (C-D).

Additional indices are also measured to defining the proportions of the ear such as:

Ear Index = Total Ear Width (T.E.W)/ Total Ear Height (T.E.H) X100

Lobular index =Lobular width (L.W)/Lobular height (L.H) X100

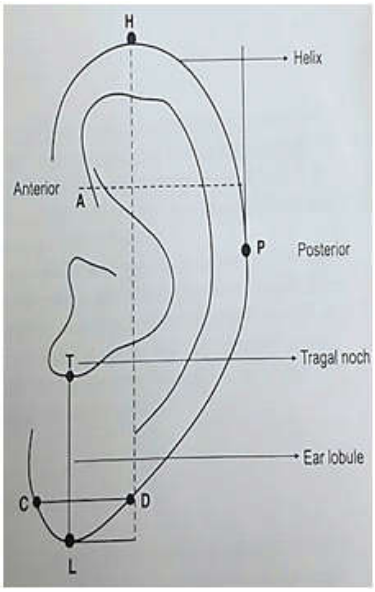

Fig 1: Reference points used for anthropometric measurements of ear. L-H: Total Ear Height; A-P: Total Ear Width; L-T: Lobular Height; C-D: Lobular Width.

All the parameters measured by a single investigator using standard digital Vernier caliper and the numerical data were analyzed using (S.P.S.S) version 16th, comparisons of measurement according to gender and various age groups were performed with independent sample t-test & paired sample t-test.

Results

The measurements and comparison of results for the right & left ears according to age group subjects

Table 1: Different morphometric ear measurements in relation to age

Measurements	Age Group (n=100)		
	17-18 years (22) Mean ±SD	9-20 years (61) Mean ±SD	≥21 years (17) Mean ±SD
Right Ear TEH (cm)	6.12±1.35	6.12±0.91	5.75±1.53
TEW (cm)	2.99±0.67	3.05±0.49	2.79±0.79
LH (cm)	1.69±0.72	1.66±0.33	1.52±0.45
LW (cm)	1.76±0.48	1.80±0.36	1.72±0.51
Left Ear TEH (cm)	5.77±1.32	6.02±1.07	5.80±1.53
TEW (cm)	2.84±0.70	3.02±0.63	2.81±0.75
LH (cm)	1.65±0.58	1.63±0.32	1.51±0.43
LW (cm)	2.05±0.58	1.88±0.41	1.78±0.52

Table 2: Right and left ear measurements and comparison of the results.

Measurements	Males (56) Mean ±SD	p-value	Females (44) Mean ±SD	p-value	Combined (100) Mean ±SD	p-value
Ear Height Right	6.20±0.95	0.734	5.86±0.97	0.289	6.11±0.75	0.592
Left	6.06±1.12		5.88±0.95		6.04±0.85	

Ear width Right Left	3.07±0.52 3.06±0.52	0.099	2.89±0.49 2.87±0.66	0.592	3.02±0.42 3.00±0.51	0.498
Lobule Right height Left	1.68±0.48 1.60±0.32	0.051	1.63±0.32 1.63±0.31	0.342	1.67±0.38 1.63±0.28	0.032
Lobule Right height Left	1.79±0.35 1.88±0.40	0.562	1.78±0.40 1.90±0.46	0.317	1.81±0.33 1.91±0.38	0.323
Ear Index Right Left	48.66±7.49 48.78±8.06	0.132	48.41±8.59 48.83±8.46	0.385	48.97±6.63 49.31±6.56	0.817
Right Lobule Index Left	110.27±26.21 115.84±29.74	0.283	108.65±21.60 114.69±26.28	0.791	110.78±21.45 116.71±25.64	0.298

According to Table 2, TEH, TEW, LH measurements are more in right ear, whereas LW, EI, LI were more in left ear but the difference between the right and left sides statistically insignificant.

Table 3: Comparison of measurements according to gender (n=100)

Measurements	Male (56) Mean ±SD	Female (44) Mean ±SD	p-value
Right ear height	6.20±0.95	5.86±0.97	0.001
Right ear width	3.07±0.52	2.89±0.49	0.001
Right lobule height	1.68±0.48	1.63±0.32	0.789
Right lobule width	1.79±0.35	1.78±0.40	0.218
Right ear index	48.66±7.96	48.41±8.59	0.823
Right lobule index	110.27±26.21	108.65±21.60	0.326
Left ear height	6.06±1.12	5.88±0.95	0.000
Left ear width	3.06±0.52	2.87±0.66	0.005
Left lobule height	1.60±0.32	1.63±0.31	0.739
Left lobule width	1.88±0.40	1.90±0.46	0.635
Left ear index	48.78±8.06	48.83±8.46	0.132
Left lobule index	115.84±29.74	114.69±26.28	0.894

According to Table-3 Total ear height (THE), Total ear width (TEW) of both right & left ears are more in male than female and the difference between the sides were significant statistically P value (0.001).

who participated in the study are shown in Table 1. The mean of TEH, EW, LH, LW were found to be increasing with advancing age in both the sexes up to 20 years, afterwards the measurements are not increasing.

Discussion

The TEH is important in the evaluation of congenital anomalies (Down syndrome) [7,8]. The ear reaches its mature height at 13 years in males and at 12 years in females [9]. In a study on north American whites, it was observed that the total height of the left ear as 62.4 mm in men and 58.5 mm in women and that the same measurements was 70.1 mm in Japanese people [10].

In Bozkir et al., study, the height of the left ear was found to be 63.1 mm in men and 59.7 mm in women [11]. In the present study TEH of left ear in males is 6.06 cm and 5.88 cm in females, which is increasing with age and found to be significantly ($p<0.001$) higher in males. The studies of Barut and Aktunc et al., and so many previous workers study supporting our study the mean height of the ears on both sides was significantly higher in males than females [12].

According to Farkas IG et al. studies the mature width of the ear is achieved in males at 7 years and in females at 6 years [7]. In a study done by Balogh B et al., E.W to be 32.4 mm for the left ear and 33 mm for the right ear in men and to be 31.9 mm for the left ear and 32.4mm for the right ear in women [13].

However, Della croce et al., reported the E.W to be 30.5 mm. According to Bozkir et al., E.W to be 33.3 mm for the left ear and 33.1 mm for that right ear in 191 men, as compared with 31.3 mm for the left ear and 31.2 mm for the right ear of 150 young women [11], while coming to our study E.W in male for the right ear is 3.07 cm and left 3.06 cm. In females for the right ear 2.89 cm and left ear 2.87 cm respectively, previous studies support our study that E.W measurement are more in male than

in females on both sides with significant p-value (0.001). According to our study right L.H & right L.W are more in males than in females but left L.H & left L.W are more in females than in males with not significant statistically. While ear indices right E. I & L. I & left L. I are more in males than in females without significant p-value. But left E.I is more in females than males. When we compare our study with those of others we find that there is a difference in the values of ear measurements & these discrepancies could be a result of factors such as race, genetic variables, individual constitution, environments, age & human error. With regards to the sex difference showed the TEH & EW were significantly higher in men than females.

An acquired deformity that develops with aging may include elongation or ptosis of the ear. This condition has been attributed to the loss of elastic fibers and gravitational forces. Earrings are an additional weight on the ears, and they therefore affect ear lobe height.

Conclusion

Knowledge about the normal ear dimensions is important in the diagnosis of congenital malformations, syndromes and acquired deformities as well as planning of treatment & hearing instruments industry. This study provides the mean values of the different morphometric measurements of right & left ears in the medical students age ranging from 17-26 years in South Indian region.

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Original Article

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Morphometric Study of Mental Foramina in Mandibles of Telangana Region

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Abstract

Introduction: On the anterolateral aspect of mandible, mental foramen is found which transmits mental nerve and vessels.It is the ending of mandibular canal which gives passage for inferior alveolar nerve and vessels. The commonly used injection for anaesthetising the mandibular teeth is the inferior alveolar nerve block. *Materials & Methods:* During osteology demonstrations, we observed accessory mental foramen in 9 (nine) mandibles with varying location with reference to mental foramen's location. We have conducted study on 35 mandibles. *Results:* We observed accessory mandibular foramen above mental foramen in 3 (three) mandibles and behind mental foramen in 6 (six) mandibles. To anesthetise anterior teeth, the possible way is to introduce anaesthesia besides mental foramen.

Keywords: Mental Foramen (MF); Accessory Mental Foramen (AMF); Inferior alveolar nerve; Nerve block; Cone beam computed tomography; Sex determination.

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Introduction

On the anterolateral aspect of mandible, mental foramen is found which transmits mental nerve and vessels. Mandibular canaldivides into mental and incisive canal and ends in the mandible through which inferior alveolar nerve and vessels passes. Inferior alveolar nerve gives rise to 2 branches namely mental and incisive within the canal. These branches supply sensory branches to soft tissue of chin, lower lip and gingival region. These branches originate from mental nerve which emerges from mental foramen on the ipsilateral side of the mandible [1].

Most useful and common injection for anaesthetising the mandibular teeth is inferior alveolar nerve block. To anaesthetise the anterior teeth including premolars and canines, it is possible to avoid giving inferior alveolar nerve block by injecting anaesthetic solution adjacent to mental foramen. To localise the important neurovascular bundle, the knowledge of position and morphological variation of mental foramen is important [2].

Mental foramina are usually observed while giving local anesthesia in order to produce mental nerve block which in turn is required in osteotomies required for various maxillofacial and orthognathic surgeries and for placing dental implants. During these procedures, the mental neurovascular bundle is prone to injuries. So, it is very important to locate its position accurately and reliably so as the occurrence of iatrogenic injuries can be prevented [18].

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Accessory Mental Foramen (AMF) can be defined as any foramen found in addition to normal Mental Foramen (MF). To achieve complete anesthesia, the knowledge of position and incidence of AMF will be helpful for dental surgeons and also useful in performing periapical surgery [2]. Variations in the position of MF are very rare but variations in terms of number have been reported on one or both sides of mandible. These additional foramina observed in the vicinity of MF are termed as accessory mental foramina (AMF). Finding AMF are said to be a rare anatomical variation. If found, theygive passage to myelinated nerves, one or more arterioles and venules. Accessory mental foramen which passes through AMF is considered to be a branch arising from inferior alveolar nerve which innervates the mucous membranes, skin of the corner of the mouth and the median labial region [15].

Materials and Methods

Study was done on 35 dried human mandibles of unknown sex in Dept of Anatomy in Shadan Medical College, Hyderabad. Position, shape and number of Accessory Mental Foramen (AMF) were measured and documented well. The positional relation of AMF with MF was observed.

Results

We found most usual position of mental foramen is below 2nd premolarin 35 specimens. Regarding the shape, we detected round mental foramen in 95% of mandibles and oval in 5% of mandibles. With respect to accessory mental foramen, we observed AMF in 9 mandibles of which 4 are bilateral and 5 are unilateral. In 3 mandibles, we observed accessory mental foramen above mental foramen. We found the mean diameter of accessory mental foramen (AMF) ranged from 0.5-1.2 mm.

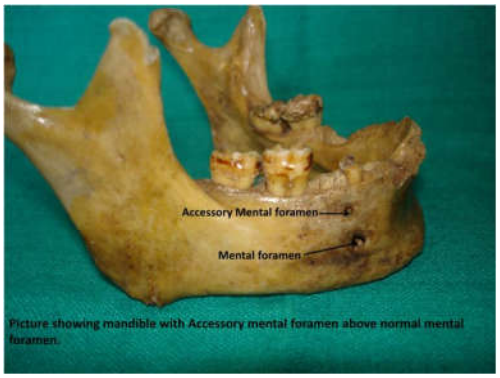

Fig. 1: Picture showing mandible with accessory mental foramen above normal mental foramen.

In 6 skulls, accessory mental foramen was observed behind normal mental foramen.

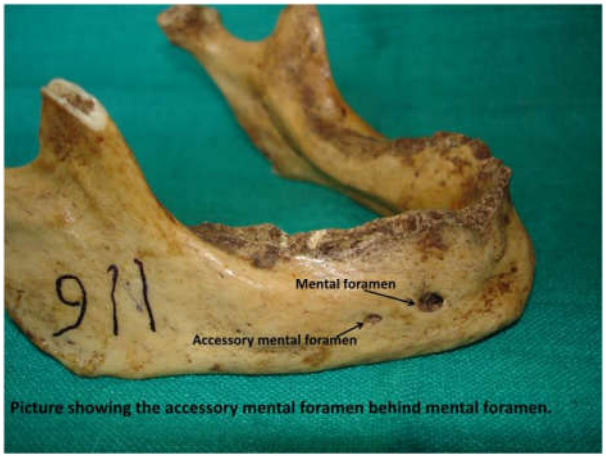

Fig. 2: Accessory Mental Foramen (AMF) behind the normal Mental Foramen (MF).

Discussion

The only movable bone of facial skeleton is mandible and it forms almost inferior half of the face. Mandible has got functional and cosmetically significance and it contributes to facial contour. In entire vertebrate history, the evolution of mandible has evoked greater interest among researchers. One of the earliest innovations in the evolution of vertebrates belongs to mandible [17]. It is interesting to note that mental foramen and supraorbital notch lie in same vertical line [16[. In the present study, shape of Mental Foramen (MF) was round in 95% of mandibles. According to Singh & Srivastav et al. (2010), the most common shape of MF was round in 94% of mandibles. Al-Khateeb et al. (2007) reported that majority of MF were round in shape similar to present study. The position of AMF was variable in relation with regular MF. In three mandibles, AMF was about 2 mm above MF and in 6 mandibles, AMF was behind MF [2].

In the present study, we observed 9 mandibles with AMF, so the rate of incidence was 12.85%. According to Gershenson et al. (1986), AMF was present in 2.8% Israeli mandibles. In Negro and Maori mandibles, highest incidences of AMF were reported [3].

Study by RK Shukla et al. (2015) [6] stated that they have observed oval shaped mental foramen (MF) was 87.1% on right side and 88.6% on left side. Janardhan Rao et al. (2017) [11] observed oval shaped foramen in 69.28% of mandibles and rounded in 30.71% of mandibles. In our study, we didn't get any disparity on sides and it is uniform

on both the sides. But, in our study, we observed oval shaped mental foramen only in 5% mandibles.

SS Bala (2017) et al. [7] found Accessory Mental Foramen in 2 cases. In our study, we observed accessory mental foramen in 9 cases.

Raj kohila et al. (2018) [15] observed AMF was either superomedial or inferolateral to the mental foramen. In our study, we didn't observe such position but AMF was either posterior or inferior to MF. They reported the average mean diameter of AMF ranged from 0.5 – 1 mm where as in our study we observed the range extended between 0.5 – 1.2 mm.

Gulrez Nadeem et al. (2018) [16] observed majority of mental foramina shape as oval where as in our study we observed majority foramina shape as rounded. Their study didn't report any presence of accessory mental foramen (AMF). In contrast, in our study we observed accessory mental foramen in 9 cases. The same study shown that the relation of accessory mental foramen to mental foramen is postero superior, but in our studywe couldn't find such relation of AMF to MF. Regarding the transverse diameter, this author reported mean transverse diameter of 3.23 mm. However, in our study this diameter ranged from 0.5 – 1.2 mm only.

Deepthi N et al. (2018) [18] observed single mental foramen in 88.5% of cases. Regarding our study we couldn't find a mandible with single mental foramen. Their study witnessed the majority mental foramen shape as oval shaped where as we found round shaped mental foramen in majority of mandibles.

LBL Prabodha and BG Nanayakkara (2006) [19] reported the average mean diameter of AMF was 1.7 mm, where as in our study it was between 0.5 mm – 1.2 mm. They also opined that the comparative size of mental foramen and accessory mental foramen was slightly higher in Sri Lankan population.

Farzad Rezaei (2018) [20] conducted their study on Iranian mandibles. They reported the common location of mental foramen was in the line of 2nd premolar. This finding coincided with our study.

Lubis MN and Anfelia (2018) [21] conducted their study on panoramic radiographs of mandibles to determine the sex. They have observed the mean transverse diameter of mental foramen was similar in males and females. However, we didn't consider this parameter as this study was done on dry mandibles.

EwaZmysłowska-Polakowska et al. [22] reported that there is no statistical difference in appearance of AMF and sex. However, we could not study the relation between sex and appearance of AMF as the study was done on mandibles of unknown sex.

Table 1: Showing comparisons of our study with different authors.

Author	Shape of mental foramen	Accessory mental foramen
Singh & Sri Vastav (2010)	Round (94%)	------
Al Khateeb (2007)	Round	-----
Gershenson (1986)	-----	2.8%
R K Shukla (2015)	Oval (87.1%)	----
Janardhan Rao (2017)	Oval (69.28%) Round (30.71%)	-----
Bala SS (2017)	-----	4.87%
Present study	Round (95%) Oval (5%)	4 (Bilateral) 5 (Unilateral right)

Conclusion

This study findings will be of great help to dental surgeon. Priya P. Roy et al. suggested that avoiding injury of mental nerve while doing surgery of that region like dental implant, apicourettage, endodontic treatment etc. [1].

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Original Article

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Human Stature Estimation from Foot Length: A Preliminary Study

Rajveer Singh Chourasia[1], Avantika Bamne[2]

Abstract

Aim: In this study an attempt has been made to derive a linear regression equation for estimation of stature from the length of foot. *Background:* Estimation of stature from foot length is considered as an important parameter in medico-legal and forensic examinations. When highly decomposed and mutilated dead bodies with fragmentary remains are brought for postmortem examination, it becomes difficult to identify the deceased. *Material Methods:* The present study is conducted on 506 medical students 255 male and 251 female of age group between 18 - 25 years, was conducted at Index medical college hospital and research center Indore. The measurements were taken by using standard anthropometric instruments are the - I. Standard flexible steel tape. II. Spreading caliper (0-300 mm). *Results:* The observed data was subjected to statistical analysis like 't' test for correlation coefficient. The value of 't' was found to be statistically significant. Simple linear regression equation derived has been used for estimation of height. *Conclusion:* It is concluded that the foot length provides good reliability in estimation of stature in forensic examinations & in medico legal cases and the correlation between present parameters can be helpful in medico-legal cases for identification of individuals. Regression equation derived can be of help in artificial limb centers for construction of prosthesis required in cases of amputations following gangrene, trauma, frostbite etc.

Keywords: Height; Foot length; prosthesis; stature.

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Introduction

The stature prediction is a relatively a central position in the anthropological research & in identification of the person by the medico-legal experts. Estimation of stature from individual skeletal material, amputated limbs, mutilated, and parts of limb has obvious significance in personal identification of murders, accidents or natural disasters mainly concerning with forensic identification analysis [1].

Whenever the body is recovered in mutilated or fragmented state, the problem of identification of the person and this is difficult for the most experienced forensic expert.

The mutilation of dead body is done by a criminal who wants to destroy all traces of identity and thus facilitate the disposal of the dead. The correlation between stature & foot length and breadth is done after linear regression equation and multiple regression equations that will help in estimating stature, whenever the mutilated or fragmentary remains of feet are recovered [2]. Maturation & Ossification in the foot occurs in earlier than the long bones and height could be more accurately estimated from foot length [3].

Material and Method

The present study was conducted on 506 Medical students 255 males and 251 females, Age group

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between 18 - 25 years old, at Index Medical College Hospital & Research Center Indore.

Methods

a) Length of foot

b) Height - Height from the vertex of subject to the standing surface, of the foot.

Vertex is the highest point of the head in Anatomical position which is obtained by joining the infra orbital margin to the upper margin of the external auditory meatus (Frankfurt's plane).

Instrument

I. Standard flexible steel tape.

II. Spreading caliper (0-300 mm).

Fig. 1: Standard flexible steel tape

Fig. 2: Photograph Show's Height Measurement

Foot length is measured with spreading caliper (0-300 mm). Foot length is measured from the most prominent point of back of the heel to the tip of the hallux or to the second toe, if second toe is longer than the hallux, when foot is rested over a flat hard surface with the help of spreading caliper

Fig. 3: Showing the technique used for the foot length

Calculation formula

The calculations were done using regression formula.

Regression: It is used to express the functional relationship between two variables. In the most basic form of this technique (simple linear regression), the value of one variable (X) eg. Age or diameter is used to predict the value of the other variable (Y) eg. diameter. In simple linear regression equation X is an independent variant and y is a dependent variant. It is particularly useful in generating curves for various diameter parameters.

Simple Linear Regression

The relationship between two variables may be one of functional dependence of one on the other. That is, the magnitude of one of the variables (the dependent variable) is assumed to be determined by i.e., is a function of the magnitude of the second variable (the independent variable). The independent variable is also called the "predictor" or "regressor" variable and dependent variable the "response" or "criterion" variable. The term "dependent" does not imply a cause-and-effect relationship between the two variables.

The simple linear regression equation follows as under

Y = a + bX

X = Independent variable [Aortic diameter above celiac trunk or Age]

Y = Dependent variable [Aortic diameter below superior mesenteric artery, celiac trunk diameter, superior mesenteric artery diameter]

Where

a = Intercept

b = Slope

Such a dependent relationship (Y = a + bX) is termed a regression, the term simple regression refers to the fact that only two variables are being considered. The regression coefficient intercept (a), generally represent the background value of the dependent variable (Y) and thus, intercept has the same units as of Y, the dependent variable. The regression coefficient (b), generally called slope, expresses what change in Y is associated, on the average, with a unit change in X. The units of b are the units of Y divided by the units of X.

Results

Total 506 medical students including 255 males and 251 females of age group between 18-25 years old were included in this study.

The various observations and results are arranged in tables and presented graphically as follows:-

Table 1: Total Foot length V/s Height in Male and Female population

S.No.	Parameter	Sex	Mean ± SD
1.	Rt. Foot length	Male	252.40 ± 11.54
		Female	227.40 ± 12.21
2.	Lt. foot length	Male	250.38 ± 11.90
		Female	227.73 ± 11.99
3.	Total height	Male	1709.05± 113.39
		Female	1533.74 ± 205.44

Table 2: Regression analysis of various parameters in male & female

Parameter	Sex	Coefficient	SE coefficient	T	P
Constant	Male	508.4	158.3	3.21	0.001
	Female	726.01	95.48	7.60	0.000
Right foot length (mm)	Male	1.998	2.050	0.97	0.331
	Female	1.835	1.134	1.62	0.107
Left foot length (mm)	Male	1.882	1.901	0.99	0.323
	Female	0.106	1.143	0.09	0.926

Table 3: Regression analysis of total height (mm) versus Right foot and Left foot length (mm) in male & female

Parameter		Sex	Coefficient	SE coefficient	T	P
Constant	Male	Rt. foot length	573.6	138.7	4.13	0.000
		Lt. foot length	631.1	131.3	4.81	0.000
	Female	Rt. foot length	907.35	56.69	16.01	0.000
		Lt. foot length	907.18	58.42	15.53	0.000
Right foot length (mm)		Male	4.4989	0.5491	8.19	0.000
Female			2.8782	0.2489	11.56	0.000
Left foot length (mm)		Male	4.2593	0.5183	8.22	0.000
Female			2.8748	0.2562	11.22	0.000

Table 4: Correlation of total height in relation to other parameter in male & Female

S.No.	Parameter	Sex	Pearson correlation	P value
1.	Right foot length & total height	Male	0.737	0.000
		Female	0.591	0.000
2.	Left foot length & total height	Male	0.750	0.000
		Female	0.580	0.000

Table 5: Total result (male & female) Regression analysis of total height versus Rt. Foot & Lt. Foot Length in combined gender males and females

Parameter	Co-efficient	SE - Coefficient	T	P	Significance	
Consent	252.40	43.33	5.83	0.000	P<.001	High significance
Right Foot length	1.4295	0.7176	1.99	0.047	P<.05	Significance
Length foot length	1.8206	0.7012	2.60	0.010	P<.05	Significane

Discussion

The estimation of Stature (height) from foot length has been attempt by many workers & in present study are compared with the study of other researchers The present study deal with the observation of total correlation of total standing height with foot length.

Table no. 1 show the mean height and mean right foot length & left foot length of male & female student in the age group in between 18 - 25 year.

Regression-equation formula in Male

Height (Y) = Constant (a) + (slope (b) X right foot length)

Y = a + (b x foot length)

(Y) = 573.6 + (4.498 X right foot length)

Height (Y) = Constant (a) + (slope (b) X left foot length)

(Y) = 631.1 + (4.2593 x lt. foot length)

Table 6: Showing comparison of foot length of present study in male and with that of the Indranil Manna, Hilmi Ozden, Anitha Oommen and Kewal Krishan's study

S. No	Researh Worker	Sex	Sample size	Side	Mean±SD
1.	Indranil Mann(4)	Male	200	Right	24.47±1.25
				Left	24.38±1.21
2.	Hilmi Ozden(5)	Male	294	Right	26.00±1.34
				Left	26.04±1.36
3.	Anitha Oommen(6)	Male	50	Right	26.21±1.27
				Left	26.00±1.56
4.	Kewal krishan(7)	Male	1040	Right	25.43±3.25
				Left	25.82±3.23
5.	Present study	Male	255	Right	25.24±1.15
				Left	25.03±1.19

The above table 6 shows that in the present study the mean value of the right foot length is 25.24±1.15 and left foot length is 25.03±1.19 and Our finding correlates with various studies in males.

Table 7: Showing comparison of foot length of present study in female and study of Hilmi Ozden, Patel S M, Devesh V Oberoi & Indranil Manna.

S. No	Research Work	Sex	Sample Size	Side	Mean±SD
1.	Hilmi Ozden [5])	Female	275	Right	23.26±1.07
				Left	23.30±1.07
2.	Patel SM [3]	Female	224	Right	22.34±1.12
				Left	22.34±1.17
3.	Devesh V. Oberoi [8]	Female	50	Right	22.43±1.17
4.	Indranil Manna [4]	Female	100	Right	22.98**±1.44**
				Left	22.14±1.05
5.	Present Study	Female	255	Right	22.74±1.22
				Left	22.77±1.19

The above table 7 shows that in the present study the mean value of the right foot length is 22.74±1.22 and left foot length is 22.77±1.19 and Our finding correlates with Patel SM [7], Oberoi DV and Manna I study, while slightly differ from Ozden H study in females.

Regression-equation formula in Female

Height (Y) = Constant (a) + (slope (b) X right foot length)

(Y) = 907.35 + (2.8782 X right foot length)

Height (Y) = Constant (a) + (slope (b) X left foot length)

(Y) = 907.18 + (2.8748 x left foot length)

Where Y = Total height

X = Foot length, Correlation coefficient (r)

Correlation coefficient (r), (height & foot length) between height and foot length is

Conclusion

The present study has established definite correlation between stature and foot-length and also regression equations have been established. It will help in medico - legal cases in establishing identity of an individual. when body are found as in mass disasters, bomb explosions, accidents etc. If either of the measurement (foot length or total height) is known, the other can be calculated and this would be useful for Anthropologists and Forensic Medicine experts. Regression equation derived can be of help in artificial limb centers for construction of prosthesis required in cases of amputations following gangrene, trauma, frostbite etc.

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Original Article

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Morphometric Analysis of the Palmaris Longus Muscle: A Cadaveric Study

Sunitha R[1], Prathap Kumar J[2]

Abstract

Background: One of the most variable muscles in the human body is palmaris longus. The donor tendon is selected for grafting is dependent on the size, length, and width of the tendon. In view of the above significance, this study is taken up with the purpose to determine the morphological variations of palmaris longus muscle. *Aim:* The palmaris longus muscle was studied pertaining to its: width & length of the fleshy belly, width & length of the tendon. *Materials & methods:* This study was conducted in Anatomy Department of following colleges: Dr B.R. Ambedkar Medical college, Bangalore, Hassan Institute of Medical Science, Hassan and Sri Devaraj Urs Academy of Higher Education and Research, Tamaka, Kolar. A total of 60 upper limbs out of which, 25 were from males cadavers & 5 were female cadavers were dissected and study was conducted from 2011 to 2014. All the measurements of palmaris longus were taken using digital vernier calipers. *Results:* The length of Palmaris longus tendon 238.4 mm and width of palmaris longus tendon is 5.94 mm. The results of this study confirms that in a South Karnataka region suggest the palmaris longus tendons would be of ideal width and strength for use as grafts in reconstructive surgery. *Conclusion:* In our study, the width of palmaris longus tendon is 5.94 mm. Hence, tendons from upper limb should be considered when strength of width is important. The palmaris longus and plantaris tendons are the most suitable tendons in reconstructive surgeries. The other tendons which are suitable are extensors of the digits and tendons of flexor digitorum superficialis.

Keywords: Palmaris Longus; Morphometric; Tendon Graft; Reconstructive Surgery; Plastic Surgery.

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Introduction

The palmaris longus is one of the most variable muscles in the human body. The selection of the donor tendon for grafting is dependent tendon size, length, and width. In view of the above significance, this study is taken up with the purpose to determine the morphological variations of palmaris longus muscle. One of the superficial flexor muscles of the forearm is palmaris longus. It has got a thin & fusiform belly and a long tendon. It takes origin from the anterior surface of medial epicondyle in common with the other superficial flexor muscles of forearm: common flexor origin, just medial to flexor carpi radialis muscle. The tendon of palmaris longus runs superficial to flexor retinaculum finally gets attached to apex of palmar aponeurosis. It is supplied by median nerve, flexor of wrist and it is a degenerate metacarpophalangeal joint flexor on evolution [1]. It is often absent on one or both sides. The literature reports that the Palmaris longus muscle is a sex-linked dominant trait [2,3].

Palmaris longus muscle has a relatively short muscular belly in comparison to the length of the tendon. The Palmaris longus possesses a long

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tendon that has a uniform oval cross- sectional shape with an even taper along its longitudinal axis and flattens and broadens as it passess anterior to the flexor retinaculum [4].

Very few fibers of palmaris longus tendon interweave with the retinaculum. The palmaris longus tendon of the splits in the palm to form fibers that are longitudinally directed and it forms a part of the palmar aponeurosis [1,5].

This study was undertaken to throw more light for surgeons performing tendon grafting, plastic and reconstructive surgeries, maxillofacial surgeons, oncosurgeons, ophthalmologists, orthopedic surgeons and anatomists. The variations of this muscle, many a times could pose problems in differential diagnosis.

Hypothetically, if the length of tendons is longer, it could indicate that the muscle is going to degenerate, hence, study of morphometry was given due importance.

Materials and Methods

This study was conducted in Anatomy Department of following colleges: Dr B.R. Ambedkar Medical college, Bangalore, Hassan Institute of Medical Science, Hassan and Sri Devaraj Urs Academy of Higher Education and Research, Tamaka, Kolar. A total of 60 upper limbs out of which, 25 were from males cadavers & 5 were female cadavers were dissected and study was conducted from 2011 to 2014. If there were visible trauma, pathology or prior surgeries in the forearm, they were excluded from the study. Dissection of the upper limb were carried out following the Cunnigham's Manual of Practical Anatomy. During forearm dissection, the Palmaris longus muscle was identified & carefully dissected. Origin was confirmed and then, it was traced towards its insertion. Morphometry analysis was done and photographed. Total length of the muscle from its origin to insertion was measured using measuring tape. Then the tendon length was obtained, from musculotendinous junction to the distal wrist crease. The width of both the belly and tendon was taken at their widest parts. Measuring tape was used to measure the length and digital vernier calliper was used to measure the width of muscle belly and its tendon. The measurements were noted down and results were statistically interpreted and then compared with previous studies.

Statistical software

The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables.

Fig. 1: Materials used for the present study

Results

In our study, Dissection of 30 cadavers (25 male, 5 female cadavers) revealed the following details:

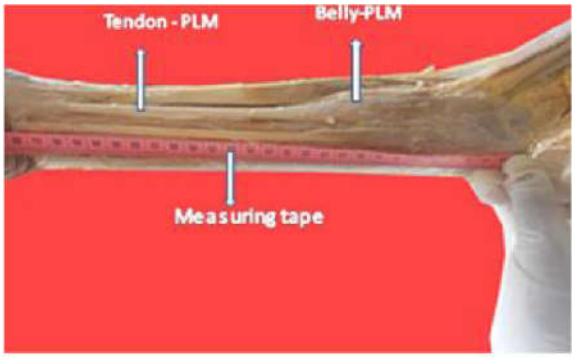

Fig. 2: Measurement of total length of palmaris longus muscle

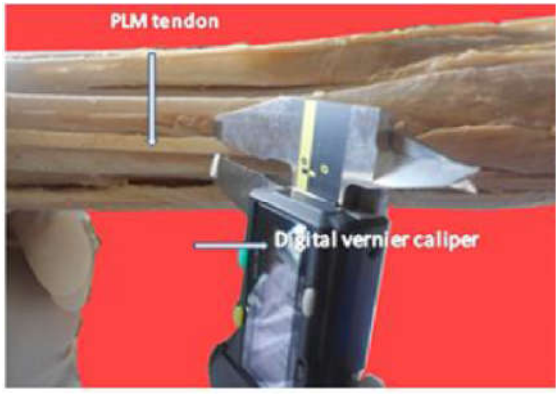

Fig. 3: Measurement of tendon width of palmaris longus by digital Vernier caliper

Two-tailed test was used to compare the difference in the mean values of Palmaris longus Right and left muscle length p=0.821, right and left total length p=0.278, right and left belly width p=0.839, right and left tendon width p=0.074.

Paired sample T test was used to compare the difference in the mean values of Rt and Lt tendon lengths and p=0.915.

Table 1: Comparison of Tendon length of Palmaris longus of both sides

Tendon length	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	13.1	2.06	9	18
Left side	29	12.9	1.85	9	16

Table 2: Comparison of Belly length of Palmaris longus of both sides

Belly length	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	11.4	2.75	9	21.5
Left side	29	11.1	2.26	8	18.4

Table 3: Comparison of Total length of Palmaris longus of both sides

Total length	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	23.2	5.31	0.53	29
Left side	29	24.0	2.30	19	29

Table 4: Comparison of Tendon width of Palmaris longus of both sides

Tendon width	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	0.57	0.21	0.20	1.28
Left side	29	0.61	0.18	0.38	1.31

Table 5: Comparison of belly width of Palmaris longus of both sides

Belly width	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	1.39	0.35	1.00	2.52
Left side	29	0.61	0.18	0.38	1.31

Table 6: Test statistics: Test used for palmaris longus

Palmaris longus	Side	Belly length	Total length	Belly width	Tendon width
Z	Left	-0.22	-1.08	-0.20c	-1.788
Asymp. Sig. (2 tailed)	Right	0.82	0.27	0.83	0.074

Discussion

The present study was to determine the morphology of the palmaris longus muscle of in Karnataka. The results of present work were then compared with that already available in the literature, done in different population groups. Present study throws light on morphometry and may aid surgeons in reconstructive surgery, using these muscles as grafts or flaps. Also, helps radiologists in analysis of the presence and/or absence of these muscles in a Karnataka.

The morphometry of palmaris longus muscle was described and slight differences were found between the current study and that reported in the literature. The prevalence of these muscles yielded the same results when compared to past studies conducted on samples/populations other than Karnataka.

The highly variable structure in the human body is muscles. Variations in the muscles can be of 3 types: it may be retrogressive, progressive and atavistic. Some muscles tends to undergo degeneration & they represent retrogressive type,

eg: palmaris longus and plantaris muscles. Some muscles become more complex & they represent progressive type, eg: deep flexor muscles of forearm. Some muscles which have been lost completely during the course of evolution and they make an abrupt reappearance again is called atavistic muscles, eg: axillary arch muscle, a remnant of panniculus carnosus [6].

Variations in palmaris longus can be a) complete agenesis; b) variation in location of muscle belly; c) aberrancy of attachment at its origin or its insertion; d) accessory slips [7] e) duplication or triplication [8].

In 11.2% of forearms, palmaris longus is absent [7]. Though it is a negligible muscle functionally but bears a morphological interest & it is absent in 13% of arms [9].

Palmaris longus muscle attached distal to the apex of palmar aponeurosis. However, other points of insertion have been described in the literature. One of interest is an insertion on to the antebrachial fascia [10].

Functionally, it is a weak flexor of wrist, so it is an expendable muscle, function of the wrist will not be affected significantly by its absence [11].

Reconstructive surgeries, their tendon is frequently used. Other tendons used are plantaris, the long extensors of the fingers and toes [12,13].

The surgeons makes the choice of donor tendon for grafting on what is needed, for example tendon length, size and width. A tendon of more than 190 mm cannot be harvested from the upper limb, while the lower limb can yield lengths up to 400 mm while the upper extremity can provide tendons as wide as 6 mm compared to lower limb that provides a maximum of width of 4 mm. An important factor to consider is that a difference in strength between a 2 mm and a 3 mm tendon width could be significant. Thus, according to Wehbe & Mawr (1992), tendons from upper limb should be considered when strength of width is important and the lower limb tendons when length is a factor [12].

The most desirable tendons in reconstructive surgery are the palmaris longus and plantaris tendons, while the long extensors of the toes and hands as well as the flexor digitorum superficialis are regarded as suitable [14].

One of the easiest tendons to harvest is the palmaris longus and plantaris tendons and therefore they remain the number one choice for tendon graft. The superficial location of palmaris makes the process of harvesting easier and these makes the procedure less complicated and safer. It is also said to be a dispensable tendon and function of the wrist is not affected significantly by its absence [15].

Kapoor and co-workers (2008) is of the opinion that there is a little functional use to the upper limb by palmaris longus in humans, but has great significance when used in reconstructive surgery as a donor tendon [16].

Upon investigation of the prevalence of palmaris longus, it was found that the percentage values, obtained in this study, correlated well with what has been reported in the literature (Table 7).

The measurements given for the tendon length of the palmaris longus muscle, in the literature, were slightly shorter than what is obtained in the current study, with the exception of Carlson and co-workers (1993) [4]. The width of the tendons measured, were wider than those described in the literature. Wehbé (1992) suggested that one should consider that an increase of 1 mm in the width of a tendon could have a significant influence in its strength [12].

The average width (0.594 cm) of the palmaris longus tendon in a Indian population met the requirements necessary for a graft to be viable in reconstructive surgery.

The belly length fell within the range given in the literature. Lastly the total length of the palmaris longus was located within the range seen in the literature. Thus, the overall measurements obtained from a Indian population in the present study coincide well with similar measurements obtained in previous studies.

Table 7: Comparison of the measurements of the palmaris longus muscle with the different studies found in the literature. The measurements are in millimetres

Authors(year)	Tendon length (mm)	Tendon width (mm)	Belly length (mm)	Belly width (mm)	Total length (mm)
White (1960) [14]	100-150	-	-	-	-
Carlson & co-workers (1993) [13]	160	-	-	-	-
Lam (1998) [15]	90-120	2-3	-	-	-
Masaaki & co-workers (2001) [17]	116.6	4.2	-	-	-
Mobarakeh (2008) [18]	136.2	4	-	-	-
Stecco(2009) [10]	80-155	-	95-230	-	225-315
Present study	90-180	3.8-13.1	80-21.5	49-25.2	190-290

When comparing the total length of the palmaris longus muscle. Masaaki and co-workers (2001) reported a statistical significant difference between males and females, in a Japanese population, but only for the length of the palmaris longus tendon, and not the muscle as a whole. Therefore only the length of the tendon could be compared to the literature. They reported an average of 12.46 cm for males and 10.83 cm for females while the current study found the average length to be 23.63 cm which correlates with study done by Stecco *et al*. This can possibly be explained by the fact that the Japanese population on average is smaller in stature compared to other population groups, and thus the length of their palmaris longus muscles will be shorter [10,17].

Mobarakeh and co-workers (2008) reported a difference between males and females, in an Iranian population. This was found to be not statistically significant: the tendon length of the palmaris longus muscle measured 14.2 cm for males and 12.8 cm for females. This shows a difference in measurements between Japanese, Iranian and a Indian population [18].

Variations in the morphology of the palmaris longus muscle were found only in a few cadavers in the present study. One case of 'reversed' palmaris longus was noted. Similar variations have been described in previous studies on the palmaris longus muscle conducted by Reimann and co-workers (1955) [19], Carlson and co-workers (1993) [4], Depuydt and co-workers (1998) [20], Oommen (2002) [21], Tiengo and co-workers (2006) [22], Natsis and co-workers (2007) [23] and Mobarakeh and co-workers (2008) [18].

Georgiev et al., (2009) reported a case of a male with Palmaris longus with a muscular belly, proximal and two tendons, distally on his left arm. The medial tendon inserted on the proximal aspect of the flexor retinaculum, while the lateral tendon passed superficial to the flexor retinaculum and inserted on the Palmaris aponeurosis [24].

Although palmaris longus is completely present on both or at least one arm in 95% of the Karnataka population, the presence of the palmaris longus muscle does not guarantee its usefulness in reconstructive surgery [25]; instead its usefulness is determined by the morphology of this specific muscle. Thus the palmaris longus muscle needs to be present in the patient, in order for it to be used in a reconstructive procedure. However, even if present it might still not be viable for use in reconstructive surgery, as variation in the morphology of the palmaris longus muscle was found during this study and described in the literature.

Morphological importance: With the development of forelimb as a prehensile organ, the long flexors muscles of the forearm, Palmaris longus muscle started degenerating in a caudo-cranial direction. Degeneration of functionless muscle occurred much earlier in phylogenetic forebearers likes Gibbon and Orangutan. Chimpanzees and apes shows maximum degeneration, only 25% of Gorillas have got Palmaris longus muscle. Palmaris longus is more degenerate in apes and monkeys than in man [26].

Embryological importance: The flexor muscles of the forearm develop from the flexor mass, which subsequently divides into 2 layers, superficial and deep. The deep layer gives rise to the flexor digitorum superficialis, flexor digitorum profundus and flexor pollicis longus. The superficial layer of flexor mass gives rise to the pronator teres, flexor carpi radialis, flexor carpi ulnaris and palmaris longus [27].

Conclusion

Palmaris longus muscle is one of the common flexor muscles of the forearm. Phylogenitically classified as retrogressive muscle as the muscle has a short belly and long tendon. The palmaris longus muscle is one of the most variable muscles in the human body, not only in terms of absence but also in terms of its muscle variation and anomalies. The surgeons make their selection of the donor tendon for grafting based on tendon size, length, and width. An important factor to consider is that a difference in strength of muscle between a 2 mm and a 3 mm tendon width could be significant. In our study, the width of palmaris longus tendon is 5.94 mm. Hence, tendons from upper limb should be considered when strength of width is important. The most desirable tendons in reconstructive surgery are the palmaris longus and plantaris tendons, while the long extensors of the toes and hands as well as the flexor digitorum superficialis are regarded as suitable. The palmaris longus tendon is preferred tendon in case of tendon graft procedure because it has a wider tendon. The palmaris longus is subjected to variations, like reversal of palmaris longus inversus and duplication of palmaris longus can compress the median nerve mimicking carpal tunnel syndrome, Guyon canal entrapment syndrome, ganglion swellings. Knowledge of these variations is important for surgeons before harvesting the tendons for graft.

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Applications of Museum Techniques of Preserving Wet Neuroanatomical Specimens for Teaching Medical Students

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Abstract

Introduction: Anatomy museum specimens are used as a visual undergraduate and postgraduate teaching aids, which are gradually replacing cadaveric teaching. Among this, neuroanatomy specimens are delicate and utmost care is required to handle them and are also difficult to obtain. This necessitates the requirement of robust neuroanatomy specimen preparation and preservation for teaching medical students. *Material and Methods:* The neuroanatomy specimens were collected after careful dissection from the cadavers using standard dissection methods. After thorough washing, the specimens were placed in 10% formalin solution for fixation. After fixation the specimens were mounted, placed in the acrylic boxes and displayed for teaching and learning in the anatomy museum. *Results and Conclusion:* The specimens resulted in better understanding of anatomical details and relations of structures. Neatly dissected, carefully preserved specimens of various sections of the brain are useful for teaching and research purposes.

Keywords: Museum Techniques; Neurospecimens.

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Introduction

The role of anatomy museum in the understanding of the subject is very important [1]. Anatomy museums are great venues for self-learning, apart from demonstrating various anomalies, encountered during dissections. This calls for a well maintained, neatly dissected and preserved specimens in anatomy museum with proper descriptions and necessary cataloging and documentations.

Anatomy museums are thus truly the places where "dead teach the living". Sadly enough, the anatomy museum often do not get the due attention they deserve. Conscious and continuous efforts for properly and systemically arranging, cataloging with relevant descriptions, constant & continuous efforts in maintaining, updating the specimens are the call of the time. The departments should make all-out efforts to improve the museums and the same should not be ignored.

The medical students find neuroanatomy difficult who face learning difficulties in understanding the complex anatomical details. The neuroanatomy specimens are delicate, utmost care is required to handle them and difficult to obtain. This necessitates the requirement of robust neuroanatomy specimen preparation and preservation for teachingmedical students [2].

The study of the neuroanatomy specimens in the museum is a useful and important tool for learning. The preparation of the neuroanatomy specimens is a daunting task which starts with the collection of the specimen from the cadavers in the dissection hall. Thereafter the specimens are washed thoroughly in

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the running water and finally fixed in 10% formalin and delicately positioned in appropriate size acrylic boxes for preservation.

Methods

The preparation of the neuroanatomy specimens involves:

- Dissection
- Preparation
- Preservation
- Mounting
- Labeling

The specimens were collected after careful dissection from the cadavers received by the department of anatomy as part of the body donation programme. After thorough washing in running water to remove the blood clots and debris, these specimens were placed in 10% formalin solution for seven days. This ensured proper fixation of the specimens. After fixation, the specimens were mounted, placed in the acrylic boxes and displayed for teaching and learning in the anatomy museum. The fixing and mounting of the specimens was carried put as per the methods described in John D Bancroft's Theory and Practice of Histological Techniques [4] as follows:-

Specimen fixation

- Formalin (40% formaldehyde) - 1 litre
- Potassium acetate - 85 gms
- Potassium nitrate - 45 gms

Restoration of the specimen

- 95% alcohol and keep it for 30 minutes - 12 hours to restored colour

Mounting of the specimen

- Gylcerine - one part
- Formalin - one part
- Tap water - 18 parts
- Thymol crystals - pinch

If the water is turbid, then filtration is required. Sealing of the boxes was done to prevent evaporation.

Sealing compound

- DPX (Distyrene Plasticiser Xylene) or cello-tape

The labelling of the specimens was done by sticking the relevant structural information with glue and secured with adhesive tape.

Outcome & Discussion

Neatly dissected, carefully preserved specimens of various sections of the brain areshown in Fig. 1,2 & 3.

With the compression of first MBBS from eighteen months to twelve months for the first MBBS students by the Medical Council of India (MCI), there has been a pressure on the faculty to complete the course in a stipulated time period. This poses a great challenge for the faculty as well as the students. The students find it difficult to grasp the basic anatomical concepts more so in a

Fig. 1: Coronal section of brain at the level of body of corpus callosum

Fig. 2: Horizontal section of Brain through right cerebral hemisphere at level of interventricular foramen

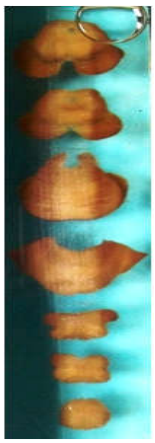

Fig. 3: Brain Stem sections from Midbrain to Medulla

complex and difficult topic such as neuroanatomy. Moreover, the neuroanatomy diagrams and atlases are of limited help. The neuroanatomical structural details can be better understood with the help of three dimensional specimens. This is further aided by the use of legends to the specimens mentioning the structural details of the specimen. Effective improvements in the students' study methods have been demonstrated by using neuroanatomy specimens prepared by new anatomical techniques for undergraduate students [3]. Though the conventional fixation of the brain is accomplished in two weeks, a perfusion technique via the middle cerebral arteries achieves the desired fixation in 5-6 days [5]. Newer teaching tools in neuroanatomy include three dimensional scans, photographs and illustrative videos [6,7,8]. The practical utility of these newer techniques in teaching and understanding of the holistic and integrated neuroanatomical structural details has been proved beyond doubt.

To accomplish the ultimate aim of helping students to understand anatomy, museum visits have been included in the curriculum and is an important part of undergraduate training in our institution. Demonstration of the neuroanatomy sections and specimens is a regular feature in the dissection Hall briefings and tutorials. Although neuroanatomical specimens are important teaching tool but an integrated approach involving study of three dimensional reconstructions, photographs, radiographs artistic sketches and illustrative videos will help in better understanding of concepts. Moreover, the photographs, radiographs and the videos are archived in the kiosk based computer software kept in the Anatomy museum for correlation and easy comprehension. The Kiosk comes handy in quickly revising the neuroanatomy curriculum especially during preparatory leave before university examinations.

In the present scenario, the medical student community comprises of heterogeneous groups and their learning objectives are quite diverse [9]. The role of anatomy teachers is that of a smooth facilitator rather than a strict teacher. Neuroscience is a complex scientific field which comprises of neuroanatomy, neurophysiology, neurohistology, neuropharmacology, psychology, neurochemistry, and neuroradiology. With the increasing population more and more clinicians encounter neurological conditions in the day to day practice. The holistic knowledge of neuroscience is an inescapable requirement for better management of these patients and the first-hand knowledge of neuroanatomy forms the solid foundation for further advancement of learning. Neuroanatomy specimens in transparent acrylic or Perspex boxes provide a three dimensional arrangement, are easier to handle and can be preserved for longer periods.

Medicine is ever changing dynamic field but the basic anatomy remains the same. The application of the museum specimens for the medical and nursing students is of great help for understanding the complex structural details of neuroanatomy. Although newer modalities of teaching like three dimensional scans and illustrative videos have been proved helpful, the importance of neuroanatomy specimens still remains unmatched.

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Anatomical Study of Renal Arteries in Human Cadavers

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Abstract

Introduction: In our study, the aim was to study renal artery of human kidneys and its variation. We present double and triple renal arteries discovered during a routine dissection of abdomen at department of anatomy. *Material and method:* 50 human kidney were studied on different numbers by dissection method in Indian people *Results:* the present study showed number of single renal artery found in 90%, double renal artery found in 6% and triple renal artery found in 4% in cases. *Conclusions:* Knowledge of these variations is important during management of renal surgery in hypertensive patient

Keywords: Double Renal Artery; Triple Renal Artery; Kidney.

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Introduction

The renal arteries arise from abdominal aorta below the origin of superior mesenteric artery, one on each side [1]. Near the hilum of the kidney, each renal artery divides into anterior and posterior branches, which in turn divides into number of segmental arteries supplying the different renal segments [2].

Classically a single renal artery supplies each kidney [3] but sometimes extra renal artery arises from either aorta or celiac trunk superior or inferior mesenteric artery etc and supply to the kidney.

The nomenclature of the variations of the renal arteries is still not clear, as different authors described them as additional, accessory, hilar, inferior and superior polar arteries [11].

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In present study we used double, triple or multiple renal arteries. Variations of the renal arteries are not unusual. The aetiology of variations has been explained by embryological development from the lateral mesonephric branch of dorsal aorta [4].

Knowledge of the variations of renal vascular anatomy has importance in exploration and treatment of renal trauma, renal transplantation, renovascular hypertension, renal artery embolization, angioplasty or vascular reconstruction for congenital and acquired lesions, surgery for abdominal aortic aneurysm and conservative or radical renal surgery [5].

Materials and methods

The 50 kidneys were taken for the study. The renal arteries of the kidneys were studied by dissection methods. The kidneys separated along the renal arteries by discarding the piece of aorta and observed extra renal arteries before removal of the kidneys from the bodies, possibilities of additional renal arteries from the common iliac, internal iliac, lumbar, sacral, superior mesenteric, hepatic and inferior suprarenal arteries were a looked upon. The dissected specimens were numbered and allowed to dry for a time. The extra

renal were observed and photographed. Specimens were preserved in 5% formalin.

Result

Normally each renal artery run laterally and near hilum divides into anterior and posterior branch, (8) The present study shows normal course in 90%, whereas, variations in 10% of cases (5 specimens – 28, 31, 32, 45, 46)

Fig. 1:

Specimen No. 28 showed triple renal artery (2 hilar{crossed} with superior polar renal artery). Polar renal artery arising from celiac trunk run laterally and supply upper pole of kidney. Whereas both renal artery arising from aorta, cross each other. Further 1st renal artery continues as anterior division and 2nd as posterior division.

Specimen No. 46 showed triple renal artery (3 hilar), all arising from aorta. 1st renal artery continue as anterior division, 2nd as posterior division and 3rd renal artery divide into anterior and posterior division

Fig. 2:

Specimen Nos. 31 & 45 showed double renal artery (2 hilar), both arising from aorta and dividing into anterior and posterior division at the hilum.

Fig. 3:

Specimen No. 32 showed double renal artery (1 hilar with 1 superior polar artery) hilar renal artery that show normal extra renal course and superior or upper polar artery that arising from aorta, run laterally, to the upper pole of kidney.

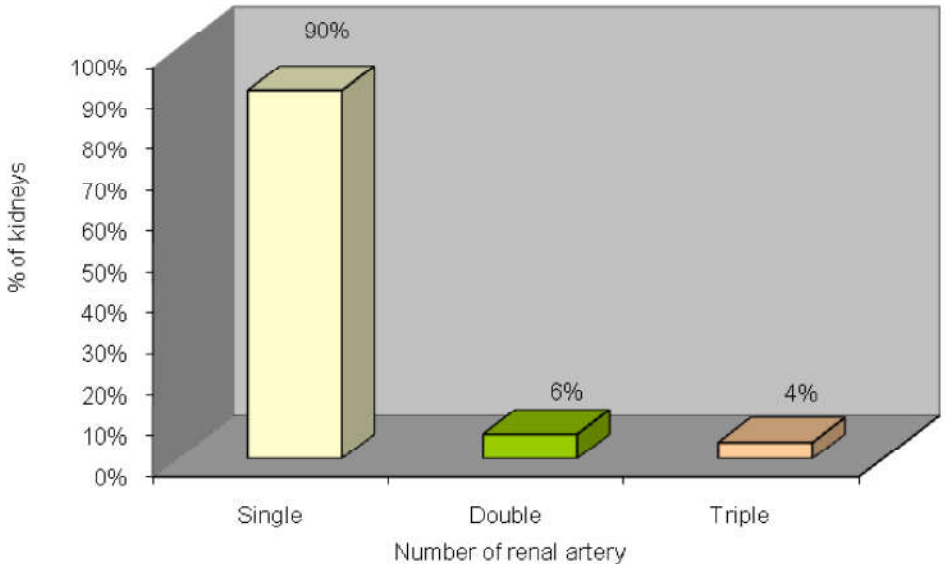
Fig. 4:

50 human kidneys were studied on numbers of renal arteries and variations also showed in table 1 and graph 1.

Table 1:

S. No.	No. of renal artery	No of kidney	Specimen no.	%
1	Single	45		90%
2	Double	3		6%
	2 HA	2	31.45	
	1 HA +1 SPA (UPA)	1	32	
3	Triple	2		4%
	3 HA	1	46	
	2 HA +1 SPA (UPA)	1	28	

X^2- value =72.28, df = 2, Significant



Graph 1:

When subjected and statistical analysis, the difference is found to be significant.

Discussions

The nomenclature of the variations of the renal arteries is still not clear, as different authors described them as additional, accessory, hilar, inferior and superior polar arteries [11]. In present study, the following nomenclature was utilized to categorize the renal arteries: Hilar artery (HA), an aortic branch that penetrate the kidney in the hilar region; superior polar artery (SPA) or upper polar artery (UPA), an aortic branch that penetrate the kidney at its superior pole and inferior polar artery (IPA) or lower polar artery (LPA), an aortic branch that penetrate the kidney at its inferior pole [6].

In present study, analyzed the numbers of renal artery in 50 dissected kidneys and shows maximum frequency of 90% in single renal artery. This correlate well with those of Hegedius [7] (1972) who studied and report on 138 patients revealed that 120 kidneys (70.6%) were supplied by single renal arteries. Sampaio FJ and Passos MA [8] (1992) analyzed the renal arterial supply in 266 kidneys dissected from 133 fixed adults subjects and revealed that 147 kidneys (53.3%) were supplied by single (1hilar) renal arteries. Khamanarong K et al. [6] (2004) to established the incidence and characteristics of variations of renal arteries in Thais. They dissected total of 267 Thai cadavers in the anatomy laboratory. The anatomical findings included: a single hilar artery in 82% of cases. Wilson F S Busato et al. [9] (2003) studied in 30 human kidneys obtained single renal arteries in 90% (27 kidneys).

Present study shows double renal arteries in 6% (3 kidneys) with 2 hilar arteries in 4% (2 kidneys) and 1 hilar with 1 superior polar artery in 2% (1 kidney) it is similar with Hegedius (1972) who after studying 138 patients revealed that (27.6%) 47 were fed by two arteries Sampaio FJ and Passos MA (1992) analyzed the renal arterial supply in 266 kidneys dissected from 133 fixed adults subjects and revealed Double renal arteries found in 20.0% (with 2 hilar arteries in 7.9%, 1 hilar artery with superior polar artery in 6.8%, 1 hilar artery with inferior polar artery in 5.3%). Khamanarong K et al. [6] (2004) to established the incidence and characteristics of variations of renal arteries in Thais. They dissected total of 267 Thai cadavers in the anatomy laboratory double renal arteries in 17% of cases (with one hilar artery with an upper polar artery occurred in 7%; two hilar arteries in 7%, and one hilar artery combined with one lower polar artery in 3%). Wilson F S Busato et al. [9] (2003) studied in 30 human kidneys obtained Double renal artery in 6.66%. Satyapal et al. [10] (2001) described double renal arteries in 31.3% of the African population in his study, 30.9% of the white population, 18.5% of the half-caste population and 13.5% of the Indian population. Bordei et al. [11] (2004) found 54 double renal arteries originating from the aorta in 272 kidneys (78%)of them on one side and six of them were bilateral (11%).

Our finding goes hand in hand with those of Wilson F S Busato et al. [9] (2003).

Who studied in 30 human kidneys and obtained Double renal artery in 6.66%. Its not correlating

with observations of Hegedius [7] (1972), Sampaio FJ and Passos MA [8] (1992), Khamanarong K et al. [6] (2004), Satyapal et al. [10] (2001), Bordei et al. [11] (2004) who shows presence of double renal arteries in 27.6%, 20.0%, 17%, 13.5%, 20% respectively. It may be due to difference in sample size.

Present study shows triple renal arteries in 4% (2 kidneys) with 3 hilar arteries in 2% (1 kidney) and 2 hilar arteries with 1superior polar a artery in 2% (1 kidney) it correlates well with those of Hegedius [7] (1972) who reported triple arteries in 3 kidneys with separate origins from the aorta with Sampaio FJ and Passos MA [8] (1992) obtaining Triple renal arteries in 3.7% (with 3 hilar arteries in 1. 9%, 2 hilar artery with superior polar artery in 1.1% and 2 hilar artery with inferior polar artery in 0.7%)and with Khamanarong K et al. [6] (2004) observing triple renal arteries occurred in 1% (with two hilar arteries with one upper polar artery in 0.4% and two hilar arteries with one lower polar artery in 0.6%) with Wilson F S Busato et al. (2003) who revealed triple renal arteries in 3.33%.

Conclusion

The study of renal arteries, shows 90% single renal artery with normal extra renal course and 10% abnormal (double and triple with frequency of 6% and 4% respectively). The presence of multiple (double and triple) renal arteries increases the complexity of renal transplantation, kidneys with multiple arterial supply being involved in a higher percentage of transplant failures than that of normal. The Inferior polar artery is more dangerous than the superior polar artery because the involvement of the inferior polar artery originating from the aorta with a retro-ureteral course is in the aetiology of hydronephrosis.

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Original Article

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Morphological Study of the Coronoid Process of Mandible in South Coastal Population

Gali Rajasree[1], Lattupalli Hema[2]

Abstract

Background: Mandible bone forms the lower jaw and has certain interesting features for its study, one of such feature is the coronoid process of the mandible which is derived from Greek word korone, (like a crown). *Aim and Objective:* The intention of this study is to determine the variations like, shape of coronoid process of mandible, Intercoronoid distance, coronoid- condylar distance and the length and breadth and thickness of the coronoid process of mandible. its prevalence in both sexes and sides. *Study type:* Gross descriptive study. *Material and Methods:* when we were taking the osteology classes for first M.B., B.S professional student's coronoid process of the mandible presented different shapes unilaterally and bilaterally also. As this was an interesting feature study was done out of my interest. 100 bones fully ossified were collected from the department of anatomy, Narayana Medical College, Nellore. The variations in the different shapes of mandible were Digital vernier calipers were used to take out the measurements and the results were statistically analyzed. *Results:* 100 dry human adult mandibles were used for this study out of which 57 belong to male and 43 belong to female. Round (22%), Triangular (44%) and Hook shaped (34%). Length of the coronoid process is 2.26 on right side and 1.89 on the left side in triangular shaped, 2.31 on right side and 1.9 on left side in hook shaped and 2.3 on right side and 1.83 on left side in rounded shaped. Breadth in triangular shaped is 1.53 on right side and 1.6 on left side. Hook shaped the breadth is 1.59 on right side and 1.61 on left side. Breadth in rounded shape was 1.74 on right side and 1.56 on left side. Thickness of the coronoid process in triangular shape on right side is 3.56 and left is 3.76, in hook shaped on right side is 3.7 and on left side is 3.82 whereas in rounded shape on the right side it is 3.72 and 3.86 on the left side. Intercondylar distance in triangular shaped coronoid process on right side is 3.12 and 3.06 on the left side, in hook shaped it is 3.13 on the right side and 3.07 on the left side, whereas, in round shaped on the right side it is 3.12 and 3.1 being on the left side. *Conclusion:* Awareness regarding the morphological shapes of the coronoid process is useful for dental surgeons for reconstructive purposes. As this can be easily harvested; it can be used for paranasal augmentation.

Keywords: Coronoid process; Shapes; Temporalis.

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Introduction

The mandible bone (whose other names being mandibulum, or jaw bone) is unpaired bone of the lower jaw and bears the lower teeth. It consists of an anterior u shaped body and has two vertically placed rami which projects upwards from the posterior parts of the body. Arising from the upper part of the ramus are two processes. The anterior of these is the Coronoid Process (so named because it resembles a crow's beak or bird's beak), is flat from side to side and triangular in shape, whose apex give attachment to temporalis muscle. Embryologically, lower jaw skeleton is derived from meckel's cartilage but the coronoid and the condylar processes do not develop from the primary cartilage but from secondary cartilages that appear along the anterior border which disappear before birth. The coronoid process may be found elongated bilaterally or unilaterally, resulting in progressive,

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painless restriction in mandibular opening, due to impingement of the coronoid on the medial aspect of the zygomatic arches. This rare condition is more common in males, etiology of which is unknown [1]. Four shapes of coronoid process were identified like triangular, hooked, round and elevated [1], and the most commonly seen were triangular and hook shaped [2]. This bone serves as graft for, alveolar floor repairs, orbital floor repair in orbital floor deformities, maxillary augmentation for maxilla facial surgeries, and repair of non union fractures of mandible [3,4].

Materials and Methods

100 dry human adult mandibles (57 males and 43 female) were taken for the study from the department of Anatomy, Narayana medical college, Nellore, Andhra Pradesh India. In the present study, the shape, length, breadth, thickness of the coronoid process were measured, inter-coronoid distance, were measured using the digital vernier caliper. Length of the coronoid process was taken from the line tangential to the deepest part of the mandibular notch to the apex. Base of the coronoid process was taken as the reference point for measurement of the breadth [16]. For the thickness mid part of the coronoid process was taken as the reference for measurement. The data was collected, and the mean, standard deviation of the values were determined and analyzed.

Exclusion criteria: The broken mandible asymmetrical and deformed mandibles were excluded from the study.

Observation and Results

A total number 100 dry mandibles, out of which 57 belongs to male and 43 belongs to female. The shapes of the coronoid process were classified into three types. Round (22%), Triangular (44%) and Hook shaped (34%). Length of the coronoid process is 2.26 cms on right side and 1.89 cms on the left side in triangular shaped coronoid process, and in hook shaped coronoid process the length is 2.31 cms on right side and 1.9 cms on left side. In rounded coronoid process the length is 2.3 cms on right side and 1.83 cms on left side. Breadth of the coronoid process in triangular shaped is 1.53 cms on right side and 1.6 cms on left side and in hook shaped the breadth is 1.59 cms on right side and 1.61 cms on left side, breadth in rounded shape was 1.74 cms on right side and 1.56 cms on left side. Thickness of the coronoid process in triangular shape on right side is 3.56 cms and left is 3.76 cms, in hook shaped on right side is 3.7 cms and on left side is 3.82 cms whereas in rounded shape on the right side it is 3.72 cms and 3.86 cms on the left side. Intercondylar distance in triangular shaped coronoid process on right side is 3.12 cms and 3.06 cms on the left side, in hook shaped 3.13 cms on the right side and 3.07 cms on the left side, whereas, in round shaped on the right side it is 3.12 cms and 3.1 cms being on the left side.

Discussion

The crown of the ramus of the mandible exhibits beak and triangular shapes [6,7,8,9,10]. Triangular and hook shaped were more common and rounded process were least common in our present study, which are similar to most of the studies. The shapes of the coronoid process were classified into three types. Round (22%), Triangular (44%) and Hook shaped (34%). In the literature double or second coronoid process is also cited [5]. These variations in the percentage may be due to dietary habits and the genetic factors which vary from region to region, and diet being the vital factor in affecting the muscular pull on the bony process which can alter the shape of coronoid process markedly.

Length of the coronoid process was taken from a tangent line drawn to the deepest part of the mandibular notch to the apex. The length of the coronoid process is 2.26 cms on right side and 1.89 cms on the left side in triangular shaped coronoid process. In hook shaped coronoid process the length is 2.31 cms on right side and 1.9 cms on left side. In rounded coronoid process the length is 2.3 cms on right side and 1.83 cms on left side in the present study. The length of the coronoid process is longer on the right side compared to left side. The reasons being genetic factors, functional factors hormonal impact, contribution and action of temporalis muscle and remodeling of the bone causing enhanced functional stress on mandible when chewing [12].

Breadth of the coronoid process in triangular shaped is 1.53 cms on right side and 1.6 cms on left side and in hook shaped the breadth is 1.59 cms on right side and 1.61 cms on left side, breadth in rounded shape was 1.74 cms on right side and 1.56 cms on left side. Thickness of the coronoid process in triangular shape on right side is 3.56 cms and left is 3.76 cms, in hook shaped on right side is 3.7 cms and on left side is 3.82 cms whereas in rounded shape on the right side it is 3.72 cms and

3.86 cms on the left side. Intercondylar distance in triangular shaped coronoid process on right side is 3.12 cms and 3.06 cms on the left side, in hook shaped 3.13 cms on the right side and 3.07 cms on the left side, whereas, in round shaped on the right side it is 3.12 cms and 3.1 cms being on the left side. These parameters of the present study are more on the right side compared to that of left side.

Coronoid processes project above the level of condyles at the time of birth. With growth of neck of the mandible it comes to lie at lower level in adults. Coronoids projecting much above the level of condyles in a mandible of late adulthood is being reported here [13]. Abnormal elongation of the coronoid process, formed of histologically normal bone without any synovial tissue surrounding it is suggestive of hyperplasia. Bilateral hyperplasia of the coronoid processes of the mandible is quite infrequent and affects mostly males between the ages of 14 and 16 with male and female ratio of 5:1. It leads to restricted mouth opening caused by impingement of the process on the medial and anterior surfaces of the zygomatic bone [14]. Craniofacial development is an extraordinarily complex process which requires the integration of multiple specialized tissues, such as the surface ectoderm, neural crest, mesoderm, and pharyngeal endoderm. Development of the lower jaw occurs mainly between the fourth and eighth weeks of gestation, from paired mandibular primordia [15]. The etiology of elongation is not yet elucidated, but several theories have been postulated, including hyperactivity of the temporal muscle that caused reactive elongation of the coronoid process, dysfunction of the temporo-mandibular joint caused by chronic disc displacement, which would be related with cases of unilateral hyperplasia and is mentioned as one of the causes of Jacob's disease. In one of the studies ankylosing spondylosis has also been said to cause mandibular elongation (Bechterew disease) [13,14,15].

Conclusion

In the present study triangular shaped coronoid process is more commonly observed followed by hook shape and rounded shaped. The length of the coronoid process is more on the right side compared to left side. The parameters of intercondylar distance were more on the right side compare to left side. There is no much variations in the parameters of breadth and thickness on either side and in different shapes. Thorough knowledge of the morphological shapes of the coronoid process is useful for faciomaxillary surgeons for reconstructive purposes, anatomists, forensic researchers, radiologists and anthropologists. Clinical application is also favorable because its size and morphology fits into paranasal region, with the additional advantages of biocompatibility, availability and reduced operation.

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Anatomy

It is a slave to me,
Another selfish human being
Who does good and bad
It never questions me
I am astounded by its loyalty

It doesn't desert me,
Even when i blame it,
For the blemishes on my face
I am astounded by its humility

In this hedge-maze life
With its ups and downs
It asks me to forgive
'All we are is flesh and bones.
Moving along, on our own.'
I am astounded by its rationality

It is the world's greatest monotony.
Nothing is as brutally honest as anatomy.

- Dedicated to My Professor Dr. S.D. Gangane, for His Lifelong Contribution to the Subject of Anatomy

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Erratum

Article Titled "**Evaluation of Gestational Age by Using Fetal Biparietal Diameter in Second and Third Trimester on Ultrasonography**"

Vaishali V. Inamdar*, Varsha R. Pande**

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The original published version of this Article contained errors in designation of second author mentioned. Designation of second author named Varsha R. Pande was mistakenly written as tutor, but designation was Assistant Professor to be readed as

Evaluation of Gestational Age by Using Fetal Biparietal Diameter in Second and Third Trimester on Ultrasonography

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The methods section should include only information that was available at the time the plan or protocol for the study was written such as study approach, design, type of sample, sample size, sampling technique, setting of the study, description of data collection tools and methods; all information obtained during the conduct of the study belongs in the Results section.

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Present your results in logical sequence in the text, tables, and illustrations, giving the main or most important findings first. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize only important observations. Extra or supplementary materials and technical details can be placed in an appendix where it will be accessible but will not interrupt the flow of the text; alternatively, it can be published only in the electronic version of the journal.

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Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, What this study adds to the available evidence, effects on patient care and health policy, possible mechanisms)? Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

References

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Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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