

Morphometric analysis of the Human Ear, examining its relationship with sexual dimorphism among Medical Students at Raipur

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Abstract

Background: The knowledge of morphometry of the normal human ear is required for the diagnosis of syndromes, surgical reconstructions, personal identification & the design of hearing aids in earphone instruments. The present study was planned to know the physical variations in ear morphometry of medical students belonging to the Chhattisgarh region.

Aim: To study the morphometric measurements of ear auricles & lobules among the student population and set the standard for the Chhattisgarh region.

Methods: Measurements were taken from 200 healthy medical students aged 18-25 years, from Pt. J. N. M. Medical College Raipur Chhattisgarh by using a digital vernier calliper & recording in a proforma after taking written consent. The parameters measured were auricle height, auricle widths lobular height, and widths of right & left ears in both males and females.

Results: The mean total auricle height and width, total lobular height and width across the entire study for both left and right sides were 59.78 ± 4.04 & 59.39 ± 4.32 , 30.89 ± 3.06 & 30.74 ± 3.18 , 20.22 ± 3.35 & 19.49 ± 3.14 and 19.04 ± 3.58 & 18.85 ± 3.70 respectively. The effect of gender on the parameters measured reached statistical significance only in the cases of left auricle width ($P = 0.0002$) and right lobular width ($P = 0.0006$); other parameters were not significant ($P > 0.05$).

Conclusion: This will be useful in surgery, forensic human identification & product designs.

Key words: Medical students, Morphometry, Auricle and lobule, Vernier calipers.

Introduction

Anthropometry refers to the study of dimensions of different parts of the human body which shows variation according to age, gender, and ethnicity. Thus, the study of these physical variations plays an important role in establishing the identity of the individual as well as holds importance in plastic surgeries and prosthesis development^[1]. The ear is divided into external, middle, and internal ear. Auricles which are part of the external ear show various depressions and elevations on its lateral surface, which makes it irregularly concave^[2]. The medial surface shows irregularities that correspond to its lateral surface and thus also shows ethnic, age, and gender variations^[3]. Yellow elastic cartilage folding

gives the characteristic shape to the auricle. However, the part of the auricle called as lobule is simply a skin fold containing fibro-fatty tissue^[2]. Embryologically, the human pinna develops in the 4th to 6th weeks of gestation. Neural crest tissues of the first and second branchial arches combine with the surface ectoderm to form six auricular hillocks. These hillocks fuse to form auricle, which finally shifts posteriorly and superiorly to attain the actual location of the ear on the face^[4].

Several studies have been reported on auricles involving various syndromes and anomalies^[5].

Malformations of the ear may be related to the size of the auricle, the shape of the ear, and the position of the ear in the face. Marfan's syndrome and Fragile

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X syndrome are reported to have macrotia which is large ears. Trisomy 13-15 and anencephaly cases have dysplastic ears. Mean ear length and measured expected ear length ratios are significantly lower in 75% of fetuses with trisomy 21^[6].

The relevance of these studies is to identify the optimal age for surgical correction of congenital malformed ears. Any defect or proportionate size of the auricle or its missing part can be corrected by cosmetic surgery. Researchers have found that with currently available techniques, biomaterial, and biomolecules the model of neocartilage can be constituted in predetermined stage and the complex 3D structure of the ear can be regenerated for tissue reconstructive surgeries^[7]. For these surgeries, the cosmetic surgeon needs data about normal auricle dimensions, the auricle's bilateral position, and general conformation. But these data varying different ethnic groups. Studies have been conducted on different populations of the world. Because the architecture of the auricles is multifarious, plastic surgeons need detailed information about its various dimensions for construction, location, and orientation of the auricular framework^[8,9].

The forensic specialist needs the auricle dimensions for identifying a person, whereas the manufacturer needs them for making ear prostheses. Because dimensions are specific to different ethnic groups^[10].

This study aimed to provide anthropometric information about the normal dimensions of the external ear such as the length and width of the auricle and lobule of the ear of central Indian populations.

Only a few studies have been reported from India and the data available is scanty. Thus, we have attempted to provide morphometric data of ears in males and females both age groups between 18-25 years residing in Chhattisgarh state of India. The parameters generated in the study will provide baseline data to help surgeons in the constructive and periauricular surgeries of the external ear. It will also prove to be helpful in industries involved in designing ear prostheses. Our study also facilitates the identification of an individual by forensic experts and anthropologists.

This study's objective was to assess how comfortable it is to wear wireless earphones. In order to examine how the product's attributes and ear size affect wearing comfort,

Materials and Methods

This was a cross-sectional observational study conducted in the period of June 2020 to Feb 2021. Measurements were taken from 200(100 male & 100 female) healthy medical students aged 18-25 years, studying at Pt. J.N.M. Medical College Raipur,

Chhattisgarh. The parameters measured were auricle height, auricle widths, lobule height, and lobule width of both ears by using a digital vernier caliper. It has been opined that total development of the external ear occurs up to 20 years of age and beyond 20 years of age are basically attributable to secondary elongation of the earlobe due to gravitational forces^[11]. Subjects with a history of craniofacial trauma, ear diseases, congenital abnormalities, or surgery of the ear were excluded from the study and have normal ear morphology belonging to Indian ethnicity were included in the study. Prior to data collection, the subjects were informed of the nature and purpose of the study, and only those who gave their written consent were included in the study. Anthropometry involves measurements of the auricle based on international standards each subject was made to sit in a natural head position in a chair with a backrest and positioned the head so that the subject look straight forward with the lower borders of the eye sockets in the same horizontal plane as the external auditory meatus (Frankfurt plane). All the parameters were measured on each of the right and left ears of the medical students. In order to minimize error risk measurements were made by the same researcher by using a digital vernier caliper in millimeters. In the second phase, data were evaluated by using a student-t test. Four linear dimensions

Figure- 1 which are the length of the auricle (H to D), the width of the auricle(A to P), lobular length (I to L), and the width of the lobule from (C to D) were measured and statistically analysed by using *t*-test with the aid of statistical package for social sciences (SPSS version 20.0). $P < 0.05$ was considered statistically significant.

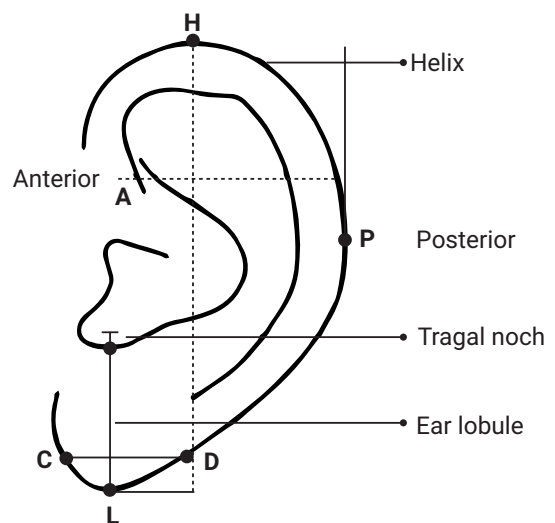


Figure 1: Showing measurements of auricle & lobule of ear

Results

The measurements and comparison of results for the right and left auricles and lobules are shown in table-1. All parameter values obtained are more in the right than left ear but not significant except lobular height.

The effect of gender on the parameters measured were higher in male as compared to female but the difference was statistically not significant. While laterality didn't affect much except in the cases of the width of the auricle and lobule.

Table 1: The mean morphometric measurements of the auricle (n=200)

PARAMETERS	SIDE	MEAN±S.D.	P-VALUE
Total Auricle Height	Right	59.78 ± 4.04	0.361
	Left	59.39 ± 4.32	
Total Auricle Width	Right	30.89 ± 3.06	0.658
	Left	30.74 ± 3.18	
Total Lobular Height	Right	20.22 ± 3.35	0.033
	Left	19.49 ± 3.14	
Total Lobular Width	Right	19.04 ± 3.58	0.624
	Left	18.85 ± 3.70	

According to Table-2, the mean auricle length of the right and left ear in males were 61.04±4.31 mm, and 60.79±4.92 mm respectively while in females it was

58.53±3.78mm, 57.99±3.42 mm respectively. The mean auricle width of the right & left ear in males were 31.96±2.91, and 31.60±2.97 mm respectively. While in females it was 29.82±3.21 mm, and 29.89±3.4 mm respectively. The mean lobular length of the right and left ear in males were 20.35±3.29 mm, and 19.47±3.15 mm respectively. While in females were 20.09±3.41 mm, and 19.52±3.68 mm respectively. The mean lobular width of the right & left ear in males was 19.91±3.75 mm, and 19.33±3.45 mm respectively. While in females it was 19.33±3.4 mm & 19.67±3.96 mm respectively.

Table 2: Comparison of auricle measurements according to gender and side (n=200)

SIDE	PARAMETERS	MEAN±S.D. (MALE)	MEAN±S.D. (FEMALE)	P - VALUE
Right	Auricle Height	61.04 ± 4.31	58.53 ± 3.78	2.011
	Auricle Width	31.96 ± 2.91	29.82 ± 3.21	1.806
	Lobular Height	20.35 ± 3.29	20.09 ± 3.41	0.587
	Lobular Width	19.91 ± 3.75	18.18 ± 3.49	0.0006
Left	Auricle Height	60.79 ± 4.92	57.99 ± 3.42	1.062
	Auricle Width	31.60 ± 2.97	29.89 ± 3.41	0.0002
	Lobular Height	19.47 ± 3.15	19.52 ± 3.68	0.920
	Lobular Width	19.33 ± 3.45	19.67 ± 3.96	0.054

Table 3: summary of various ear morphometric studies. Numbers represent distances in millimeters

Study	Population	Male auricle Length	Male auricle Width	Female auricle Length	Female auricle Width
Deopa et al ¹	Indian subcontinent	60.4	30.4	57.6	28.8
Alexander et al ¹⁷	Indian subcontinent	68.9	36.0	60.9	31.2
	Caucasian	65.2	34.4	60.4	31.3
	Afro-Caribbean	62.7	33.8	60.4	32.3
Farkas et al ¹⁸	AmericanCaucasian	62.4	35.4	58.5	33.5
Bozkir et al ¹⁴	Turkish Caucasian	63.1	33.3	59.7	31.3
Ferrario et al ¹³	Italian Caucasian	63.1	38.1	57.3	35.0
Daoudi W et al ¹⁶	Nigerian	55.0	34.0	55.0	34.0
Sangeetha.S et al. ¹⁵	Indian subcontinent	59.9	31.2	56.7	28.7
Present study	Indian subcontinent	60.91	31.78	58.26	29.85

Discussion

Anthropometry is an important tool for examining any morphological structure. Many congenital syndromes are usually associated with structural or topographical auricular deformity. Early diagnosis is very important to manage prognosis^[12]. The present study focused on morphometric measurements of auricle length, auricle width, and length & width of lobule in medical students belonging to the Chhattisgarh region.

The human ear is defining feature of the face. Studies have been conducted in different populations of the world. Differences between the right and left parts of the human face specially difference between paired

structures such as ear & eye are well known in healthy people^[13]. Similarly, we found significantly higher lobular height in the right side as compared to left lobule of the ear. Bozkiret *al.* (2006) also reported symmetry of ear dimension^[14]. Significant differences seen in the width of lobule (p=.0002) and auricle (p=.0006). It is more in males as compare to female. When both sides are compared, the current study observed symmetry in the ear dimensions measured.

Total auricle height in both gender in our study is found to be almost similar with the study done by Deopa et al.^[1] and Sangeetha et al.^[15] in Indian subcontinent. While value was less with our findings in the study done by

Olasunkanmi et al.^[16] in the Nigerian population. Study done by Alexander et al.^[17] in the Indian subcontinent, Caucasian and Afro Caribbean population, Bozkiret al.^[14] in Turkish population and Ferrario et al.^[13] in Italian population the values obtained were higher than our present study. While similar values obtained in case of females by Ferrario study. Auricle width obtained in our study is almost similar with values obtained from Deopa et al.^[1] and Sangetha et al.^[15] in Indian subcontinent may be due to same geographical

environment.

Auricle width obtained in our study is more or less similar with the study done by, Deopa et al and Sangetha et al in Indian subcontinent. While Study done by Alexander et al in Indian subcontinent, Caucasian and Afro Caribbean population, Farkaset al.^[18] in American population and Ferrario et al.^[13] in Italian population the values obtained were higher than our present study.

Table 4: showing various morphometric studies in ear lobule

Authors names	Study location	Gender	Sample size	Side	Ear lobule length Mean \pm SD	Ear lobule width Mean \pm SD
Japatti SR et al. ²²	ACPM and H Maharashtra	Male	49	right	11.57 \pm 2.69 mm	20.14 \pm 2.872 mm
				Left	11.39 \pm 2.53 mm	19.69 \pm 3.33 mm
		Female	107	right	11.27 \pm 2.58 mm	18.86 \pm 3.223 mm
				Left	11.28 \pm 2.53 mm	18.79 \pm 3.188 mm
Yadav VD et al. ²¹	SMS Medical College Jaipur Rajasthan	Male	129	right	22.11 \pm 3.4mm	26.2 \pm 3.9mm
				Left	21.2 \pm 2.7mm	23.5 \pm 3.3mm
		Female	129	right	21.7 \pm 3.0 mm	24.4 \pm 4.2 mm
				Left	20.7 \pm 2.3 mm	23.1 \pm 3.8mm
Sangeetha S. et al. ¹⁵	TOMCH and RC Bangalore Karnataka	Male	192	right	22.1 \pm 3.4 mm	26.2 \pm 3.9mm
				Left	21.2 \pm 2.7 mm	23.5 \pm 3.3 mm
		Female	192	Right	21.7 \pm 3.0mm	24.4 \pm 4.2 mm
				Left	20.7 \pm 2.3 mm	23.1 \pm 3.8 mm
Nigam R et al. ²¹	RMCH and RC Kanpur, Uttar Pradesh	Male	62	right	19.0 \pm 3.0 mm	19.6 \pm 3.1mm
				Left	18.3 \pm 3.1 mm	20.2 \pm 6.5mm
		Female	58	right	20.2 \pm 3.0 mm	18.9 \pm 3.5mm
				Left	20.9 \pm 6.4	20.0 \pm 5.4 mm
Archana Kumari et al. ²³	IMS, BHU Varanasi, Uttar Pradesh	Male	100	right	16.48 \pm 2.37 mm	18.21 \pm 2.75 mm
				Left	17.04 \pm 2.30 mm	18.08 \pm 2.31 mm
		Female	100	right	15.97 \pm 1.77 mm	15.93 \pm 2.18 mm
				Left	16.53 \pm 1.57 mm	16.31 \pm 2.10 mm
Present study	Chhattisgarh India	Male	100	right	20.35 \pm 3.29mm	19.91 \pm 3.75mm
				Left	19.47 \pm 3.15mm	19.33 \pm 3.45mm
		Female	100	Right	20.09 \pm 3.41mm	18.18 \pm 3.49mm
				Left	19.52 \pm 3.68mm	19.67 \pm 3.96mm

Study done by Sharma A et al.^[19] showed breadth and thickness of ear lobule also shows statistically growth in same age group. Lobule length in our study obtained value is almost similar with the study done by Nigam et al.^[20] Sangeetha s et al.^[15] and Yadav et al.^[21], while values obtained by Japattiet al.^[22] and Archana et al.^[23] is less than present study. Lobular width measured is similar with the study done by Japatti et al and Nigam et al, while values are more in the study done by Sangetha S et al and Yadav et al. Archana et al found almost similar value in male but less in female.

Wang et al.^[4]. (2011) reported that LLs and LW were not significantly different between males and females. Ekanemet al.^[24]. (2010) observed that in all parameters measured, males had higher mean values compared

to females. Some other studies have reported that boys had larger ears than girls (Brucker et al.^[12] 2003; Ferrario et al.^[13]. 1999; Bozkir et al.^[14]. 2006.

Thus, we conducted this study to generate interest and further research on the knowledge of ear dimensions, especially in the central part of India, where data is limited. The data provided will help in diagnosing of congenital and acquired deformity and will also provide guidelines to plastic surgeons to correct deformity. Moreover, the data provided will help in recent developments of medicine, such as, tissue engineering of ear cartilage for reconstructive surgeries.

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