Research Article

Photogrammetric morphometric analysis of auricle

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ABSTRACT

Background: In humans, auricle is the most unique feature of the face and its structure shows the signs of age and sex. The understanding of various dimensions of auricle with regard to different age and sex is necessary for forensic purposes, corrective reconstruction and to determine accurately the position and orientation of auricular framework. It will also serve as a base to guide surgeons involved in the management of cases of the external ear. **Objectives:** The study was conducted to determine the baseline mean values of the different morphometric measurements from the bilateral auricles and any prevailing sexual dimorphism regarding morphology of the auricle. **Materials and Methods:** The study was carried out on 100 individuals including both male and female of an equal number of age group 18–30 years in the Department of Anatomy, AIIMS, Patna. The standardized photometry method was used to take photographs of lateral views of subject faces. The photographs were transferred to computer and analyzed. The parameters such as auricle length (AL), auricle width (AW), lobule length (LL), lobule width (LW), auricle index (AI) and lobule index (LI) were taken using on screen digital MB-Ruler - the triangular screen ruler ver. 5.3. **Results:** The shape of the ear was found to be oval in most of the individuals. The auricle length (AL) was more in females than in males and auricle width was found to be more in male than in female subjects. Lobular length (LL) and lobular width (LW) were found to be greater in males than in females. Most of the left ear indices were found to be greater than right ones in female subjects. **Conclusion:** The present study would serve some purposes in ear morphology and for anthropometric considerations. Photogrammetric method can be used as a tool for morphometric analysis of external ear.

KEY WORDS: Auricle; Ear Index; Lobular Index; Photometry

INTRODUCTION

The external ear is not simply an ear trumpet but the first of a series of stimulus modifiers in the auditory apparatus. It consists of the auricle or pinna and the external acoustic meatus. The lateral surface of the auricle is irregularly concave, faces slightly forward, and displays numerous eminences and depressions.[1]

The auricle is a single thin plate of elastic fibrocartilage covered by skin, its surface molded by eminences and depressions. It is connected to the surrounding parts by ligaments and muscles and is continuous with the cartilage of the external acoustic meatus. There is no cartilage in the lobule or between the tragus and the crus of the helix, where the gap is filled by dense fibrous tissue.[1]

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Anterior and posterior extrinsic ligaments connect the auricle with the temporal bone. The anterior ligament extends from the tragus and the spine of the helix to the root of the zygomatic process of the temporal bone. The posterior ligament passes from the posterior surface of the concha to the lateral surface of the mastoid process.[1] Extrinsic auricular muscles connect the auricle to the skull and scalp and move the auricle as a whole. Intrinsic auricular muscles connect the different parts of the auricle.[1]

In humans, auricle is the most unique feature of the face as it contributes to facial complex by its symmetry and appearance

and shows the signs of age and sex.[2] Over the years, several studies on the photometry, cephalometric, and anthropometric study of normal auricle have reported age-dependent changes in the dimension as well as sexual dimorphism.[3-5] Among these, photometry is the most convenient and useful method. It will also serve as a base to guide surgeons involved in the management of cases of the external ear.[6] The understanding of various dimensions of auricle with regard to different age and sex is necessary for forensic purposes, corrective reconstruction, and to determine accurately the position and orientation of auricular framework. The present study was conducted to attain a thorough knowledge about morphometric and morphology of external ear.

Aims and Objective

The aim of this study is to determine the baseline mean values of the different morphometric measurements from the bilateral auricles and any prevailing sexual dimorphism regarding the morphology of the auricle.

MATERIALS AND METHODS

The present cross-sectional study was conducted in the Department of Anatomy, AIIMS, Patna. The inclusion criteria consisted of normal external ear of individuals of age group between 18 and 30 years which consisted of 100 individuals with 60 adult males and 40 females. Subjects with altered morphology by congenital anomaly, trauma, accidents, and surgery or due to any disease were excluded from this study.

External ear was visualized and observations regarding shape, pre-auricular region, external acoustic meatus, anterior surface of each auricle, and earlobe attachment were tabulated. The subjects were photographed to obtain the lateral surface of the auricle with the help of digital camera mounted on a stand and maintained at a distance of 1 m between the subjects and camera.

Each subject was made to sit in a natural head position on a chair with a backrest such that the subject looks straight forward with lower border of the eye sockets in the same with the external auditory meatuses. All measurements were taken twice to ascertain accuracy and images were transferred to a computer for analysis. The parameters were analyzed using on-screen digital MB-Ruler - the triangular screen ruler ver. 5.3.

The following parameters were observed and taken [Figure 1]:

Auricle length (AL): Uppermost point of auricle to the lowermost point of lobule.

Auricle width (AW): From the root of the auricle to maximum convexity of the helix.

Lobule length (LL): From the lowest point of attachment of external ear to the head to the ear lobe free margin.

Lobule width (LW): From the most lower attachment of the ear lobule to the head and to outermost maximum transverse width of the ear lobule.

Auricle index (AI): is defined as a percentage ratio of width and length of an auricle.

Lobule Index (LI): is defined as a percentage ratio of width and length of lobule.

All measurements were statistically analyzed by calculating their mean and standard deviations. Appropriate test of significance was applied to find the difference in mean and proportions.

A two-tailed *t*-test (independent and paired samples *t*-test) at the 95% confidence interval was used to study the bilateral variation as well as to check for statistical significance. A $P < 0.05$ was considered to be statistically significant.

RESULTS

The oval shape of the auricle was commonly found more in case of females as compared males and the anterior surface of auricle was found normally of rolled helix type. The lobule was mostly of free type [Table 1]. The various parameters such as auricle length (AL), auricle width (AW), lobule length (LL), lobule width (LW), auricle index (AI) and lobule index (LI) were compared between right and left side among males and females respectively. The LL, LW and LI were highly significant on comparing right and left side in male group. The LW and LI were highly significant on comparing right and left side in female group [Table 2].

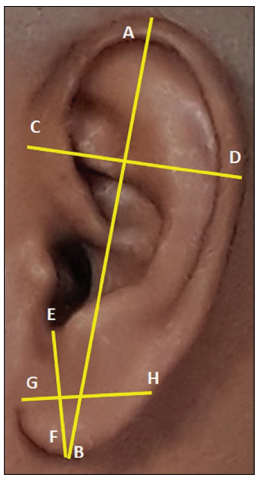

Figure 1: The points selected on photograph of ear to measure the various parameters. (A) Upper most point of auricle, (B) Lower most point of lobule, (C) Root of the auricle, (D) Maximum convexity of the helix, (E) The lowest point of attachment of external ear to the head, (F) Free margin of the ear lobe, (G) The most lower attachment of the ear lobule to the head, (H) Outermost maximum transverse width of the ear lobule

The statistically significant gender dimorphism was also found in the left side parameters such as AL and LL only. The auricle length (AL) and lobule length (LL) were found to be more in males. The statistically significant right side parameters such as AL was found to be more in female group, whereas AW and LL were more in case of male group. The AI was statistically significant both on the right and left sides for gender differences. It was found to be more in females as compared to the males. Moreover, within the male group, the right and left difference was also found to be statistically significant.

Table 1: Gender-based observations of characteristics of auricle

Characteristics	Observations\	Male (%)	Female (%)
Shape of auricle	Round	25	25
	Oval	51.7	55
	Triangular	23.3	20
Preauricular region	Normal	100	100
Anterior surface of each auricle	Flat helix	3.3	0
	Rolled helix	75.0	72.5
	Wide helix	21.7	27.5
Ear lobule attachment	Free	90.0	95
	Attached	10.0	5
External acoustic meatus	Normal	100	100
	Narrow	0	0

DISCUSSION

In the present study we found that mean auricular length, in males were higher values than in females. On comparing, the ear indices it was observed that left auricle index found to be greater in females than right ones in males but same on both sides in male subjects. The mean lobular width on left side found to be greater than the right in females and also similar in case of males lobular width. It is observed that lobular width and auricular parameters showed that there were significance difference in the males and females.

Bozkir *et al*.[7]and Ferrario *et al*.[8] found that the ear indices of both sides in males were significantly higher than females. Deopa *et al*.[9] found that the ear indices of both sides showed no statistical difference though left ear indices were found to be higher than right ear indices. Brucker *et al*.[10] in his study found that sexual dimorphism exists in ear dimensions between males and females with higher values in males. Barut and Aktunc[11] observed that the left ear indices were found to be significantly higher than the right ear indices for all the subjects. Ito *et al*. concluded that larger values were obtained for males than females in almost all age groups.[12]

This is a baseline study for taking the anthropometric measurements in Bihar region. The present study would serve some purposes in ear morphology and for anthropometric considerations. Photogrammetric method can be used as a tool for morphometric analysis of external ear. The ear lobule morphometry from this study gives information on sexual

Table 2: Comparison of each gender between the left (Lt) and right (Rt) sides by various indices

Parameters	Male		*P* value	Female		*P* value
	Mean±SD (mm)	Range (mm)		Mean±SD (mm)	Range (mm)	
AL						
Rt	37.58±4.80	53.62–92.63	0.936	64.50±6.91	53.07–80.57	0.615
Lt	74.74±8.69	54.41–108.12		63.98±9.1	46.23–86.92	
AW						
Rt	37.83±5.34	26.46–50.79	0.522	34.22±3.86	26.5–43.58	0.655
Lt	37.32±6.04	25.39–49.98		34.61±6.16	23.63–49.53	
LL						
Rt	22.14±3.75 *	13.82–29.95	0.054	20.42±2.62	14.81–25.01	0.139
Lt	21.11±4.02 *	13.8–32.69		19.66±3.18	12.72–26.48	
LW						
Rt	27.58±5.39 *	15.87–40.46	*0.001	27.05±3.83 *	16.96–37.03	*0.004
Lt	31.47±8.51 *	17.45–77.82		29.32±4.65 *	19.81–39.89	
AI						
Rt	50.00±4.63	37.93–63.35	0.453	53.13±4.38	46.49–62.48	0.369
Lt	50.64±4.22	42.78–63.38		54.05±5.19	37.77–65.85	
LI						
Rt	125.92±7.36*	76.56–186.19	*0.000	133.67±19.45*	89.31–168.46	*0.005
Lt	150.99±3.91*	101.08–362.79		151.78±26.44*	104.64–255.05	

*Denotes statistically significant value $P<0.05$. AL: Auricle length, AW: Auricle width, LL: Lobule length, LW: Lobule width, AI: Auricle index, LI: Lobule index

dimorphic which would help in forensic investigation. It would serve as data baseline for plastic surgeons involved in ear reconstruction. Since this was a preliminary study, the further correlation can also be done with respect to other facial parameters and with respect to age changes.

These results support the finding that sexual dimorphism does exist and showed statistically significant differences between the sexes. The onscreen digital MB-Ruler for taking measurement of the various parameters is highly useful tool.

CONCLUSION

The present study would serve some purposes in ear morphology and for anthropometric considerations. Photogrammetric method can be used as a tool for morphometric analysis of external ear.

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