



## Morphometry of The Human External Ear : A Study of Indian Population

**\*Jyoti Singhal, Susmita Saha, Prachi S Aneja, Nidhi Lal, Devika Agnihotri, Gagandeep Kaur**

<sup>1\*</sup> Jyoti Singhal (PhD) Student, Department of Anatomy, Medicine and Health Sciences SGT University, Gurugram, Haryana,

<sup>2</sup> Susmita Saha (MBBS, MD Anatomy) Professor, Department of Anatomy Faculty of Medicine and Health Sciences SGT University, Gurugram, Haryana,  
Email- [drsusmita.sh@gmail.com](mailto:drsusmita.sh@gmail.com)

<sup>3</sup> Prachi Saffar Aneja, (MBBS, MS Anatomy) Professor and Head, Department of Anatomy Faculty of Medicine and Health Sciences SGT University, Gurugram, Haryana,  
Email- [dranejaprachi@gmail.com](mailto:dranejaprachi@gmail.com)

<sup>4</sup> Nidhi Lal Assistant Professor Department of Anatomy Faculty of Medicine and Health Sciences SGT University, Gurugram, Haryana,  
Email- [drnidhilal25@gmail.com](mailto:drnidhilal25@gmail.com)

<sup>5</sup> Devika Agnihotri Assistant Professor Department of Anatomy Faculty of Medicine and Health Sciences SGT University, Gurugram, Haryana,  
Email- [devika.agn3@gmail.com](mailto:devika.agn3@gmail.com)

<sup>6</sup> Tutor PhD scholar, Department of Anatomy, Faculty of Medicine & Health Sciences, SGT Medical College, Budhera, Gurgaon – 122505, India

**\*Corresponding Author E.mail:** [jyotee69@gmail.com](mailto:jyotee69@gmail.com)

### ABSTRACT

The pinna is most significant or the decorative tool of the human face, which gives an idea to find stages of development as well as gender. In the facial complex auricle is an important component. Pinna's shape, size, spatial location is also playing a vital role from aesthetic point of view. Normal ear anatomy also has special role in symmetry to rectify any deformity, malformation etc. To understand the anatomical landmarks of the auricle and their morphometry in the present study. In the existing study which is morpho-metric in nature was done on 400 students of Teerthanker Mahaveer Medical College and Research Centre. There were 200 males and 200 females. By the technique of photography, we examined the parameters through digital camera and adobe photoshop software. Mean and standard deviation of distance from tragus to anti-helix of males in left and right ear (distance from tragus to anti-helix were  $1.66 \pm 0.30$ cm, distance from tragus to anti-helix of left ear =  $1.64 \pm 0.31$ cm) and from tragus to anti-helix of females in left and right ear (distance from tragus to anti-helix of right ear =  $1.61 \pm 0.30$ cm, distance from tragus to anti-helix of left ear =  $1.60 \pm 0.31$ cm). The mean and standard deviation of distance from tragus to helix of males in left and right ear (distance from tragus to helix were  $2.19 \pm 0.32$ cm, distance from tragus to helix of left ear =  $2.14 \pm 0.36$ cm) and from tragus to helix of females in left and right ear (distance from tragus to helix of right ear =  $1.40 \pm 0.27$ cm, distance from tragus to helix of left ear =  $1.39 \pm 0.36$ cm). Length of Concha in males were (right ear =  $2.00 \pm 0.25$ cm, left ear =  $1.94 \pm 0.30$ cm) and the conchal length of females are (right ear conchal length =  $1.71 \pm 0.42$ cm, left ear conchal length =  $1.68 \pm 0.45$ cm) while width of concha in males are (right ear =  $1.19 \pm 0.19$ cm, left ear =  $1.12 \pm 0.24$ ) and conchal width of females are (right ear conchal width =  $1.14 \pm 0.23$ cm, left ear conchal width =  $1.12 \pm 0.24$ cm) respectively. Our cohort conclude that medico-legal importance means to minimise the crime by ear dimensions and for personal identity for different groups, races, sex etc.

**KEYWORDS** - External ear, morphometry, measurements, photography.

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### INTRODUCTION

Johann Casper Lavater is the person who was first described the study of ear and that was used by so many individuals like Haken Jorgensen. Otomorphology or the Earology included the appearance of the auricle such as prints of fingers; they are varying from every personality [1]. Auricle is most idiosyncratic feature of the face. So many researchers trust that accomplishment of growth of pinna, also size increases after that [2-4]. The symmetry and the appearance of the pinna are important for facial congruence.[5]

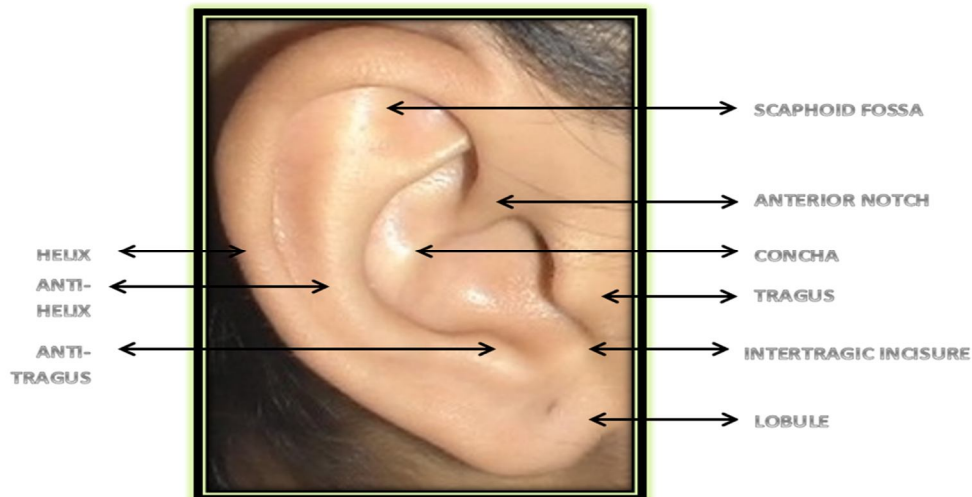
**Aesthetic Relationship:** *Leonardo da Vinci* noted that the adult vertical ear length was approximately equal to the distance between the root of the helix and the lateral orbital rim at the level of the brow. The width of the ear is approximately 55% of its length. The rim of the helix protrudes 1-2cm from the skull.<sup>[6]</sup>, and there is an average protrusion angle of 21-25 degree.<sup>[7]</sup>

**The external human ear comprises: -**

- Internal ear
- Middle ear and
- The pinna, auricle, external ear.

**The auricle further comprises: -**

- Pinna
- External acoustic meatus



**FIG: -1 HUMAN EXTERNAL EAR**

**FACTS OF EAR EMBRYOLOGY**

Embryologically the auricle is formed by the appearance of some tissue elevations they are six in numbers, the auricular hillocks, they are present around the margins of the dorsal portion of the first pharyngeal cleft. On the cranial end of the second pharyngeal arch there are three and on caudal end of the first branchial arch there are three. Anterior most hillock on the first branchial arch, tragus formed afterward and remaining part of the auricle is formed in the second arch mesenchyme, that expands forward around the posterior edge of the rest first pharyngeal cleft, shows an elevation which is made an indication of helix. Lobule of an auricle which is lastly develop.<sup>[8]</sup>

Alfred Iannarelli and Alphonse Bertillon made a classification system with many successes for the pinna.<sup>[9-10]</sup> At that time prominent forensic scientists and Bertillon considered the pinna to be a distinctive body part.<sup>[11-16]</sup> The need of this study to measure different parameters of external ear that help to solve some purposes like: -

**Hearing apparatus:** - to design the hearing aids like ear microphones, protrusion of an ear is so much helpful.

**Medico-legal purpose:-** in the forensic medicine and criminology ear parameter like ear lobule which is affect by the age dependent changes on persons identity is signifies through photograph or by ear prints.

**Prettification:-** the females of different region, tribes, states etc mostly decorate their ear by beautiful ornaments so that the external ear is also used as an ornamental tool.

**Recognition:-** not for the recognition of an individual who are from different races, background but the measurement of ear dimensions are important for the growth assessment and development.

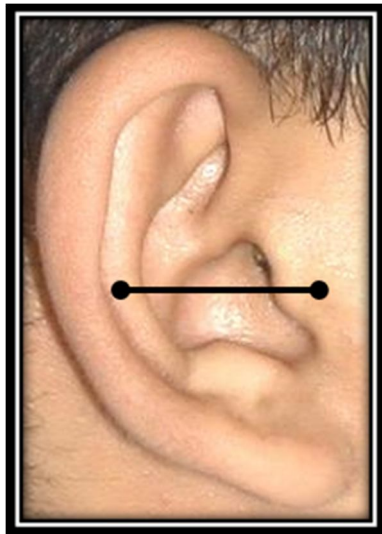
**Prosthesis:-** knowledge about the human ear play an important role to rectify the ear deformity. Ear transplantation is done by the plastic surgeons malformation like microtia, so guidelines about ear dimensions are helpful.

**J. Singhal, et.al**

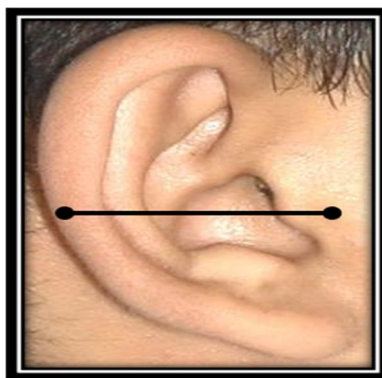
**MATERIALS AND METHODS**

Our study includes auricle with special aspects which are further important for study. Healthy persons of Teerthanker Mahaveer Medical College and Research Centre were involved in this study and the age group preferred 18-25 years. There were 400 subjects with normal external ear. The present study includes four parameters for measurements.

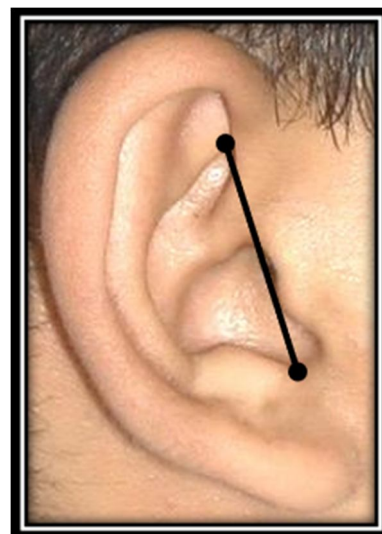
**Distance from tragus to antihelix: -**



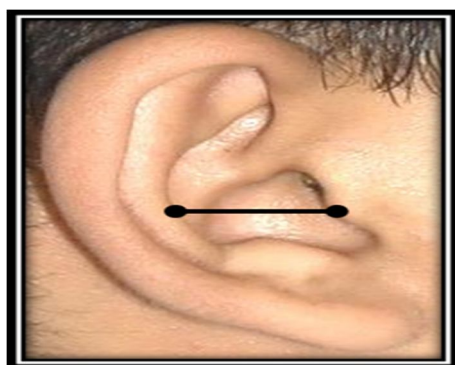
**FIGURE: - 2** Measure the gap between the most anterior point of the tragus and protruding point of the antihelix.



**FIG-3** Measure the gap in between the most anterior point of the tragus and highest point of helix.



**FIG-4** Measurement of the distance between the superior concha and intertragic incisura.



**FIG-5** Measurement of the distance between anterior curve part of antihelix and posterior most part of the tragus.

**MATERIAL REQUIRED: -**

**Camera:** High image quality in day light as well as in dim light

Has unique ability which enable to design the good photography.

These features make images clear as well as perfect for the measurements.

**Adobe Photoshop software (version 7.0):** This is the software which is used to improve the size, contrast, brightness, and made a clear image for the dimensions.

**Inclusion Criteria: -**

Healthy subjects about the age group of 18-25 years.

Individuals who were North Indians.

Attentive individuals were included.

**Exclusion Criteria: -**

Normal auricle morphology was changed by birth or any ways like any injury.

**Process: -**

Rules to use by photography method: -

Person who is sitting on the chair comfortably and place the camera properly.

Frankfurt plane was used for passing a line which was mid horizontal and passing a line which was mid vertical aligned through camera, and person to ask straight to find a sagittal plane in the middle.

We maintain a distance approx. 90cm from lens to the subject and fulfil the criteria to take pictures.

After taken the images use Adobe Photoshop software (version 7.0) to evaluate the dimensions.

At the very first we take a good photo to make landmarks over there.

## STATISTICS

We consider the t-test to compare the dimensions taken from both auricles of males and females. Calculate both Average and S.D for different parameters for study purpose.  $p < 0.05$  (statistically significant).

## RESULTS

Our study included total 400 participants who were the students of Teerthanker Mahaveer University. In our cohort both male and female participants are included. This study pertaining some ear parameters for measurements.

**Table: -1 Comparison of Left-Right Distance from Tragus to Antihelix**

Measurements	Male MEAN±SD	Female MEAN±SD	t-value	p-value
RIGHT	1.66±0.30	1.61±0.30	0.96	0.34
LEFT	1.64±0.31	1.60±0.31	0.83	0.41

**Figure: -6 To compare Left-Right Distance from Tragus to Antihelix In males and females**

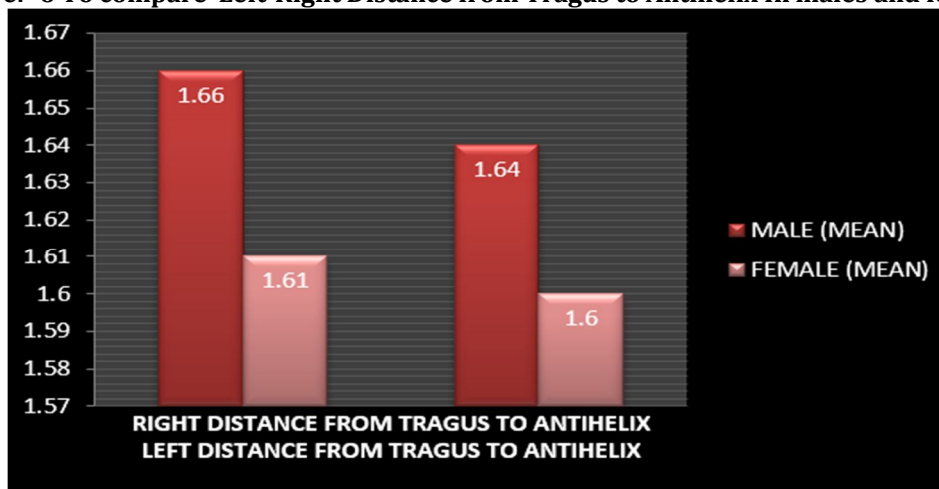


Table: -1 First column conveys the result from tragus to antihelix of males in left and right ear (distance from tragus to antihelix of right ear =  $1.66 \pm 0.30$  cm, distance from tragus to antihelix of left ear =  $1.64 \pm 0.31$  cm). Second quadrant shows that the mean and SD of distance from tragus to antihelix of females in left and right ear (distance from tragus to antihelix of right ear =  $1.61 \pm 0.30$  cm, distance from tragus to antihelix of left ear =  $1.60 \pm 0.31$  cm). Third quadrant showing that the t-value of distance from tragus to antihelix in both the genders (t-value of right ear = 0.96 cm, t-value of left ear = 0.83 cm). Fourth quadrant showing the p-value of distance from tragus to antihelix in females and males (p-value of right ear = 0.34 cm that is  $>0.05$  and the value is insignificant statistically and (0.41 cm = left ear) that is  $>0.05$  also show insignificant statistically).

**Table: -2 to compare the Right-Left Distance from Tragus to Helix In males and females**

MEASUREMENTS	MALE MEAN±SD	FEMALE MEAN±SD	t-value	p-value
RIGHT	2.19±0.32	1.40±0.27	18.86	<0.05*
LEFT	2.14±0.36	1.39±0.36	14.51	<0.05*

**Figure: -7 To Compare the Right-Left Distance from Tragus to Helix**

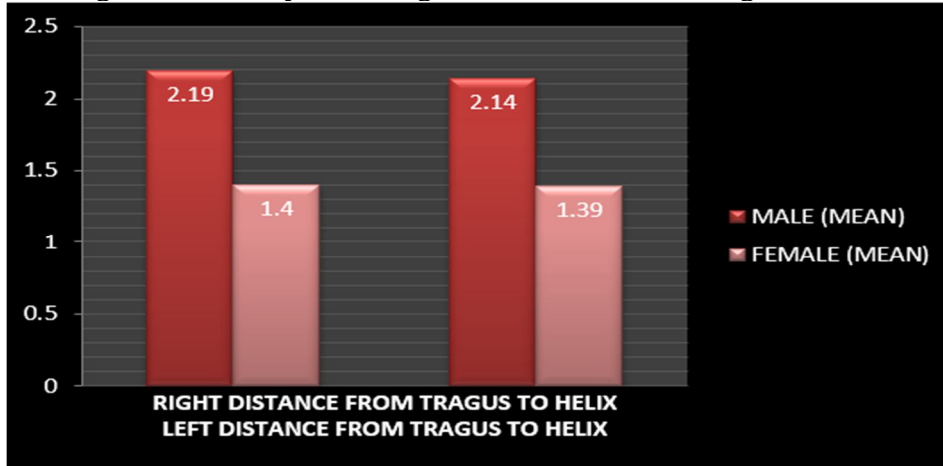


Table: -2 First column conveys the result from tragus to helix of males in left and right ear (distance from tragus to helix of right ear =  $2.19 \pm 0.32$  cm, distance from tragus to helix of left ear =  $2.14 \pm 0.36$  cm). In the second column we see the result that distance from tragus to helix of females in left and right ear (distance from tragus to helix of right ear =  $1.40 \pm 0.27$  cm, distance from tragus to helix of left ear =  $1.39 \pm 0.36$  cm). Third quadrant showing the t-value of distance from tragus to helix in both genders (t-value of right ear = 18.86 cm, t-value of left ear = 14.51 cm). Fourth quadrant showing the p- value of distance from tragus to helix in two sexes that is males and females (right ear =  $<0.05$  this is statistically significant and left ear =  $<0.05$  is also statistically significant).

**Table: -3 Conchal Length Comparison in Right and Left Ears**

MEASUREMENTS	MALE MEAN $\pm$ SD	FEMALE MEAN $\pm$ SD	t-value	p-value
RIGHT	2.00 $\pm$ 0.25	1.71 $\pm$ 0.42	6.02	$<0.05^*$
LEFT	1.94 $\pm$ 0.30	1.68 $\pm$ 0.45	4.87	$<0.05^*$

**Figure: -8: Left-Right Ear Conchal Length**

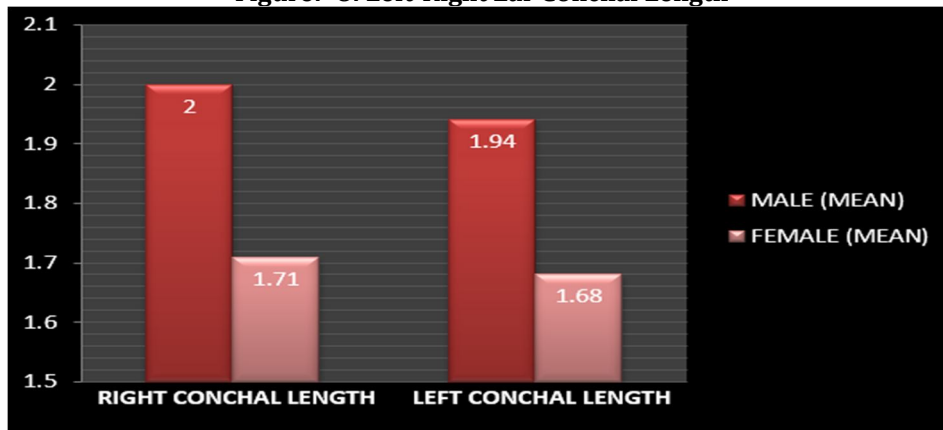


Table: -3: Ist column has result of left and right CL of males are (right ear CL =  $2.00 \pm 0.25$  cm, left ear conchal length =  $1.94 \pm 0.30$  cm). In the column IInd we found that (right ear conchal length =  $1.71 \pm 0.42$  cm, left ear conchal length =  $1.68 \pm 0.45$  cm). in the IIIrd column have t- values (right ear CL = 6.02 cm, t-value of left ear conchal length = 4.87 cm). Column IVth have (right ear conchal length p-value =  $<0.05$  that is significant value and left ear CL in both =  $<0.05$  also significant).

**Table: -4 To Compare the Left-Right Conchal Width in Males and Females**

MEASUREMENTS	MALE MEAN $\pm$ SD	FEMALE MEAN $\pm$ SD	t-value	p-value
RIGHT	1.19 $\pm$ 0.19	1.14 $\pm$ 0.23	1.58	0.12
LEFT	1.12 $\pm$ 0.24	1.12 $\pm$ 0.24	0.09	0.93

**Figure: -9Right and Left Comparison of Conchal Width**

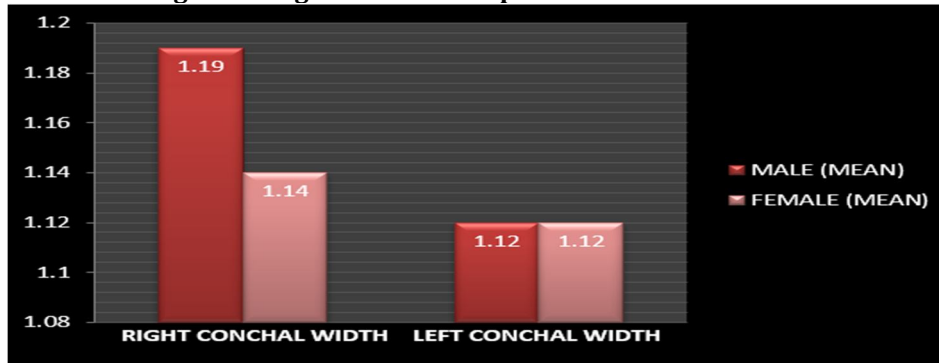


Table: - 4 first column shows conchal width of males (right ear conchalwidth =  $1.19 \pm 0.19$  cm, left ear conchal width =  $1.12 \pm 0.24$  cm). In the second column left and right conchal width of females (right ear conchal width =  $1.14 \pm 0.23$  cm, left ear conchal width =  $1.12 \pm 0.24$  cm). t- value of right and left ear conchal width = 1.58cm, 0.09 cm in third column. P-value of right ear conchal width = 0.12 cm, left ear conchal width in both = 0.93 cm which is statistically insignificant) shows by fourth column.

## DISCUSSION

The human face has important feature i.e., external ear or pinna which is very distinguishing. The structural phenomena of pinna as a symbol for determination of genders and their age. Mostly researchers after study trust that ear grow then large continuously in shape and size. [2-4] Former observations shows that ear sizes not interpret the ability and accuracy of hearing. But the pinna is itself a decorative and recognisable tissue associated with appearance and creativity of individual's face. [17] In a study by *M.G Bozkir*, the mean observations of distance of (tragus-helix, antihelix) are essential for the planning of hearing aid materials. Therefore, they were found to be 2.63 cm, 1.72 cm respectively in males bilaterally and mean observation of the similar parameters in females were found to be 2.51 cm and 1.66 cm respectively. [17]

*Bo Wang et al*, revealed their result that the width of the concha has no significant difference in both the gender that is male and female. [18] *Kalciouglu et al*. present their result that the width from tragus to helix and antihelix was reliable points for ear abnormality and also important for the hearing aid companies. He said that there was statistical insignificant difference between both the gender. [19]

*Purkait R. et al*. discussed their result that chonchal length and width of the concha increases in their size with age out of the 415 healthy subjects divided in five groups. [20] According to the results of our study the mean values were found to be  $2.19 \pm 0.32$  cm (tragus- helix) and  $1.66 \pm 0.30$  cm (tragus-antihelix) in right side of male population in which the mean value of distance from tragus to antihelix having statistically insignificant value. The left side ear of males also shows insignificant value of same parameter i.e.,  $1.64 \pm 0.31$  cm and the mean value of distance from tragus to helix were found to be  $2.14 \pm 0.36$  cm which was statistically significant. Similarly in the female subjects shows the insignificant different means value for right and left side of ear parameter that is the distance from tragus to antihelix were found to be  $1.61 \pm 0.30$  cm and  $1.60 \pm 0.31$  cm respectively. But the mean observation of the distance from tragus to helix in female population shows statistically significant values in both right and left side i.e.,  $1.40 \pm 0.27$  cm and  $1.39 \pm 0.36$  cm respectively. Our study concludes that length of the concha in both the genders in right and left ear parameters shows statistically significant values and conchal width shows statistically insignificant values in both the genders in right and left auricular parameters.

## CONCLUSION

External ear is an organ of the human body which is increasing day by day means increment of auricle done with the individual's age. Some study shows that it happens age dependent changes. Earology is necessary for the racial differences, sex, age etc. because ear parameters work as tool for a person's identification. Morphology and morphometry data are important for give an idea about any kind of malformation. Photographic method is easy as other methods because it shows a very clear picture and that's why it is also helpful for criminology. Some parameters not show any statistical significance so that no necessity to include the study for further research.

## CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest. The research received no specific grant from any funding agency in the public, community, or non-for profit sectors.

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