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Study of External Ear Indices by Digital Photometry among Adult Population

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Abstract

Background: External ear is a defining feature of the face as it contributes to facial aesthetics by its appearance and symmetry. Its shape and size is influenced by age, sex and ethnic origin. Features of auricle had long been recognized as an important anthropological variable for studying racial variability and for identifying few genetic abnormalities at an early stage of life. Out of all available methods to study external ear indices, digital photometry is most convenient and useful method. *Objectives:* To study external ear indices using digital photometry among adult population. *Methods:* The present cross sectional study consisted of 500 adult subjects between 20 to 30 years of age. Patients with malignancies, previous surgery or trauma to the earlobe, or congenital earlobe anomalies were excluded. Ear features were then captured using a digital camera mounted on stand. Various soft tissue landmarks were tagged on the photo and the various tagged points were connected on the photo. Different parameters on right and left ear were measured. The indices like auricular, lobular and conchal were computed. The measurements were statistically analyzed by calculating their mean and standard deviations. *Results:* There were 250 women and 250 men. Oval shape of auricle was more common both in males as well as in females. Auricular and conchal index in males as well as females on right and left side were statistically insignificant. These indices were significantly different in both genders. Lobular index in males on right and left side was statistically not significant, but was significant in females. Gender wise lobular index on right side was statistically significant. *Conclusion:* The result of the present study also can be used in the field of Forensic Science for excluding criminals. Ear Biometrics is a promising new passive approach to Human Identification system used for screening people. This knowledge will be useful in designing a new identification tool-'Ear Biometrics'

Keywords: External Ear; Indices; Digital Photometry.

Introduction

External ear is a defining feature of the face as it contributes to facial aesthetics by its appearance and symmetry. The ear is the organ that detects sound. The outer ear is the only visible portion of the ear in humans and almost all vertebrates and consequently the word "ear" may be used to refer to the pinna alone. The ear is an important component of the facial complex which gives an impression of its bearer's age and sex. Its size, shape and spatial location on the face are important from an aesthetic point of view. The external ear is composed of three primary components: the helixantihelical complex, the conceal complex and the lobule [1]. Though shape, size and orientation of each external ear is unique as fingerprint it is plausible to make some conclusion; male have larger ears than the female counterpart [2,3]. Various studies have been conducted on morphometry of the external ear from different parts of the world [4,5,6]. These studies prove that much variability exists depending on the age, sex, ethnic group and even in the same person between the right and left ears. Photometry, cephalometric and anthropometric methods are used to take

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measurements of ear. Among them photometry is most convenient and useful method. Features of auricle had long been recognized as an important anthropological variable for studying racial variability and for identifying few genetic abnormalities at an early stage of life [5]. Hence the present study is an attempt to examine various parameters of the external ear in adult population by photometry.

Material and Methods

The present cross – sectional and descriptive study was conducted in the Department of Anatomy, Bharati Vidhyapeeth Medical College and Hospital, Sangli. The individuals were selected randomly from Sangli district for external ear morphometry. The study was approved by Institutional Ethical Committee. The inclusion criteria consisted of individuals between 18 to 30 years of age with normal external ear. Individuals whose normal external ear morphology has been altered by congenital anomaly, trauma, accidents, surgery and due to any disease were excluded from the study. External ear was thoroughly visualised and observations regarding shape of auricle, pre-auricular region, external auditory meatus, anterior surface of each ear, tragus, ear lobe attachment, hypertrichosis were tabulated. After written informed consent from the study participants, the somatoscopic features of the external auricle were recorded. The subjects were photographed to obtain the lateral surface and the posterior view of the auricle with the help of a digital camera (Sony Cyber Shot, 16.0 Megapixel) mounted on a tripod stand against a green curtain and maintaining a distance of 90cm between the subject and the lens.. All necessary precautions and standard guidelines were followed as per the protocol. Mid vertical grid line of camera aligned to pass through the mid-sagittal plane of face, while the mid horizontal passed through the Frankfurt horizontal plane. Digital images were transferred to a computer and the images were edited in Adobe Photoshop CS3 Lite. Computerized color print copies of all photographs were taken of 5.83" length and 4.13" width which is ISO standard for postcard size. Photographs were analyzed by first marking the various soft tissue landmarks on the photo and drawing relevant lines on the images. All the various soft tissue landmarks were tagged on the photo as per the protocol. The various tagged points were connected on the photo to bring about relevant lines on the image. All measurements were recorded and the indices were calculated. The various indices were calculated by using following formulae:

1. Auricular index = The width of the auricle(mm) / length of auricle (mm)X 100
2. Lobular index = The lobular width (mm)/ lobular length (mm) X 100
3. Conchal index = The conchal width (mm)/ conchal length (mm) X 100

The photographs taken were used for research purpose only. The measurements were statistically analyzed by calculating their mean and standard deviations. Appropriate test of significance were applied to find out the difference in mean and proportions.

Results

The present cross sectional study consisted of 500 adult subjects between 20 to 30 years of age. There were 250 women and 250 men. Different parameters on right and left ear were measured as shown in Figure 1, 2 and 3. It was observed that oval shape of auricle was more common in males (78.0%) as well as in females (62.4%) followed by round shape in males (13.6%) and in females (21.2%). Triangular shape was rarely found in (8.8%) males and (15.5%) in females. The anterior surface of each ear showed normally rolled helix in 46.8% males and 51.0% females. Next most common type was wide helix covering scapha, found in 40.8% males and 38.8% females. Flat helix was found more common in males than females. It was observed that females showed a higher proportion of small tragus than males. The developmental defects of auricle were higher in females (6.4%) than males with the observation of slight hypoplastic auricle or shape deformity. 6.8% of males showed helical pattern of hypertrichosis followed by meatal and lobular in only 0.8%. The other somatoscopic observations as per gender are shown in Table 1. The auricular index did not differ significantly between right and left side in both males and females. Similarly the conchal index also did not differ significantly on both right and left side in both males and females. The lobular index between right and left side was significant in female population in this study, while it was insignificant in males. The findings are shown in Table 2.

The gender wise comparison between male and female auricle on right side showed significant difference in the mean values of all the 3 indices. With regards to left ear auricle, the mean values of lobular index between male and female population did not show any statistically significant difference. The other 2 indices like auricular index and conchal index

showed a statistically significant difference between the mean values among the male and female population ($p < 0.01$). The findings are shown in Table 3. The test of significance applied was 'Z' test. The present study proves that much variability exists depending on the gender and even in the same individual between right and left ears.

Table 1: Gender wise Somatoscopic observations of auricle

S. No.	Characteristic	Observations	Percentage (%)	
			Male	Female
1	Shape of auricle	Round	13.6	21.2
		Oval	78.0	62.4
		Triangular	8.8	15.5
2	Pre-auricular region	Normal	100.0	100.0
3	External auditory meatus	Normal	100.0	99.2
		Narrow	0.0	0.8
4	Anterior Surface of each ear	Flat helix	12.8	9.2
		Normally rolled helix	46.8	51.0
		Wide helix covering scapha	40.8	38.8
5	Tragus	Normal	90.8	79.6
		Small	6.8	18.8
		Large	2.4	1.6
6	Developmental defects	None	99.2	93.6
		Slight hypoplastic and shape deformity	0.8	6.4
7	Earlobe attachment	Free	95.6	95.6
		Attached	4.4	3.6
		Hypoplastic attached earlobe	0.0	0.8
8	Hypertrichosis	Absent	92.4	NA
		Helical	6.8	NA
		Meatal	0.8	NA
		Lobular	0.8	NA

NA-Not applicable

Table 2: Comparison of various indices among each gender between right and left side

Index		Male				Female			
		Right (mm)	Left (mm)	Z value	p value	Right (mm)	Left (mm)	Z value	p value
Auricular index	Mean	48.6	48.4	- 0.58	> 0.05	50.0	49.6	- 0.97	> 0.05
	SD	4.6	4.3			3.9	3.8		
Lobular index	Mean	155.4	151.6	- 1.27	> 0.05	166.2	157.1	- 2.62	**< 0.01†**
	SD	36.1	34.4			40.8	36.8		
Conchal index	Mean	67.8	66.5	- 1.19	> 0.05	72.1	70.4	- 1.83	> 0.05
	SD	12.3	12.5			9.6	10.9		

SD- Standard deviation, † Highly significant

Table 3: Comparison of various indices between gender on each side

Index		Right Ear				Left Ear			
		Male (mm)	Female (mm)	Z value	p value	Male (mm)	Female (mm)	Z value	p value
Auricular index	Mean	48.6	50.0	- 3.58	< 0.01†	48.4	49.6	- 3.46	**< 0.01†**
	SD	4.6	3.9			4.3	3.8		
Lobular index	Mean	155.4	166.2	- 3.12	< 0.01†	151.6	157.1	- 1.81	> 0.05
	SD	36.1	40.8			34.4	36.8		
Conchal index	Mean	67.8	72.1	- 4.26	< 0.01†	66.5	70.4	- 3.67	**< 0.01†**
	SD	12.3	9.6			12.5	10.9		

SD- Standard deviation, † Highly significant

Fig. 1: Is markings on ear

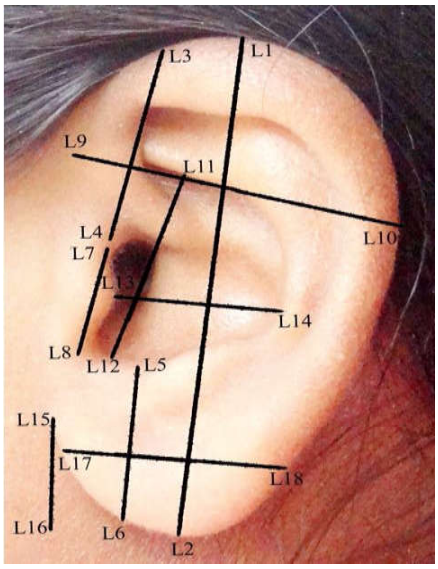

Fig. 2: Is lines on these markings

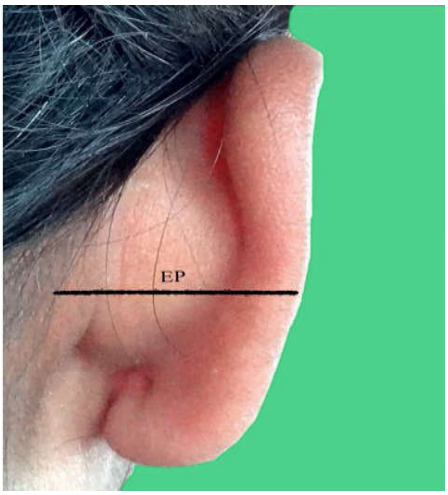

Fig. 3: Is posterior view

Discussion

Appearance and bilateral symmetry of external ear contribute to the facial aesthesis. Any external ear deformity like disproportionate size, abnormal elongation of the ear lobe or a missing part, all this can be corrected by surgery. Facial rejuvenation and cosmetic surgery have been quite popular in western countries and now in India [7]. The current study initiates a step in this direction to furnish data for males and females from Maharashtra because they form a major part of Indian population. Existence of sexual dimorphism in external ear dimensions was documented [8,9]. It was shown that sexual dimorphism exists in auricular linear dimensions between males and females with higher values in males [10]. The auricular indices of ear in present study did not significantly differ between right auricle and left auricle in both male and female populations. The results were in accordance with Kumar P et. al [11]. Bozkir et al [9] and Ferrario et. al [12] found that the ear indices of both sides in males were significantly higher than females similar to the findings in the present study. The findings were in contrast to those reported by Barut and Aktunc observed insignificantly higher right ear indices and significantly higher left ear indices in males [13]. External ear linear dimensions can serve as additional tool for age estimation of individuals [14]. The mean values for all parameters of ear morphometry reported in the literature by different scientists vary in different populations. This could be due to several factors such as differences in age, number of subjects, gender of the subjects and geographical conditions, moreover the method adopted. Deopa et al. [15] found that the ear indices of the both sides showed no statistical difference although left ear indices were found to be higher than the right ear indices for all Indian subjects.

Conclusion

This study provides the mean values of the different morphometric measurements of the left and right ears in both male and female adult population. The results support the findings that sexual dimorphism does exist and showed the statistically significant difference between the sexes. The morphometry of auricle is important in the diagnosis of congenital malformations, acquired deformities, syndromes and in the treatment planning. This study would prove helpful to plastic surgeons to reproduce an anatomically correct ear during its reconstruction. This study gives new auricular indices of adult

population in this part of Maharashtra. The ear lobule morphometry gives information on age and sex which plays a valuable role in forensic investigation. Ear Biometrics is a promising new passive approach to Human Identification system used for screening people. This knowledge will be useful in designing a new identification tool-'Ear Biometrics'

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