Anthrometric measurements of external ear:
An in vivo study

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Abstract: This study aimed at determining the mean values of the different morphometric measurements from right and left ears and at giving information about sex-related dimensions of ear, right-left symmetry, and aged related changes. Measurements are taken from 177 healthy subjects (84 women and 93 men) aged 17-25 years using a vernier caliper. The parameters measured were total ear height (TEH), ear width (EW), lobular height (LH), and lobular width (LW) for each subject's right and left ears. Comparisons were performed by independent t-test and paired samples t-test.

Keyword: External ear, Anthropometry, Ear Lobule, Human Auricle.

Introduction

Many studies have defined human body parts and their proportions to each other morphometrically. In human, ear is the defining feature of the face and its structure shows the signs of age and sex. The human ear is divided into external, middle, and internal parts. Pinna and external acoustic meatus form the external ear. The lateral surface of the pinna is irregularly concave, faces slightly forward and displays numerous eminences and depressions. These structures do not merely act as trumpet; they are the first of series of stimulus modifiers in the auditory apparatus. Anthropometry refers to the measurement of living human body dimensions for the purpose of understanding human physical variations as it plays an important role in plastic surgery, prosthetics etc. Saha observed that there were differences in anthropometric data of people of people from different regions in India. Jung and Jung surveyed the dimensions and characteristics of Korean ears and found that age, gender, and different ethnic populations were determinations of ears dimensions.

A study carried out in India observed that North-west Indians have smaller ear lobules when compared to Caucasian and Japanese populations but similar to those found among the Onge tribe of Andhra (India) and Newars of Nepal by Sharma et al. Since anthropometric data should be established for the user population as anthropometric data for northern Indian region is scant, the present study attempts to provide this anthropometric data for the ear. The study is intended to describe the anatomical height and width of ear and lobule amongst subjects (aged 17-25 years). Form these data, it is envisaged that anatomical and morphological differences and changes of the ear in relation to age and sex in our population would be established.

Material and Methods

Subjects: This study was carried out on 177 subjects in O.P.D of D.A.V Dental College Yamunanagar with no evidence of congenital ear anomalies or previous ear surgeries. The study cohort consisted of 84 females and 96 males, aged 17-25 years. The purpose of study was explained to them. Willingness and cooperation of the subjects to participate in the study was considered.

Anthropometric Measurements: Bilateral sizes of auricles were measured. Standardized measurements of the ear pinna were taken according to the land marked points defined by De Carlo et al and the methodology was adopted from McKinney et al and Brucker et al. the parameters measured were total ear height (TEH), ear width (EW), lobular height (LH), and lobular width (LW) for each subject's right and left ears, when the head was in the Frankfort horizontal plane. (Figure 1) shows the measurement of ear reference points used for anthropometric measurements.
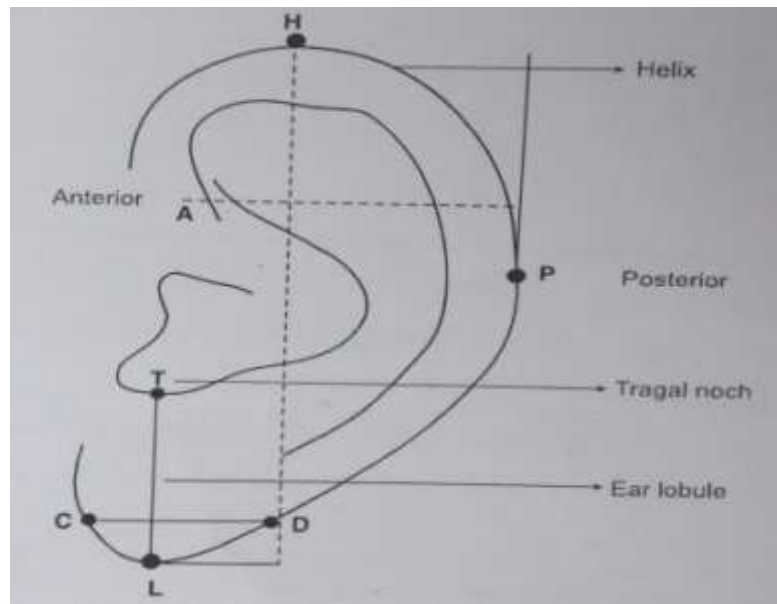
Fig 1: Reference points [Total ear height = L-H ; ear width = A-P ; lobula height =L – T ;lobular width = C- D]

The TEH was measured as the distance form the most inferior projection of the ear lobule (L) to the most superior projection of the helix (H). The EW is measured as the distance between the most anterior (A) and posterior (P) points of the ear. The LH was taken as the distance from the most inferior end of the lobule (L) to the base of the tragal notch (T). The LW was measured as the transverse or horizontal width of the lobule (C-D). (Figure 2) Shows the measurement of ear by a vernier caliper.

Fig 2 : The measurement of ear with a vernier caliper. (Total ear height)

Additionally, the indices defining the proportions of the ear such as ear index were calculated. All the measurements using the vernier calipers capable of measuring to the nearest of 0.1mm. For each subject, the measurement were carried out twice to ascertain accuracy and the arithmetical mean of the two measurements was used for each dimension.The numerical data were analyzed using a statistical Package for Social Science Version (SPSS) 20.0. Comparisons of the measurements according to gender were performed using an independent samples t-test. Comparison of measurements taken from the right and left ears of a given sex was performed using a paired sample t-test.

Result

The measurement and comparison of results for the right and left ears according to age group subjects who participated in the study are shown in Table 1.

Table 1: Different Morphometric Ear Measurements in Relation to Age.

Measurements		Age group (n)		
		17-19 years (104)	20-22 years (61)	23-25 years (12)
		Mean ± SD	Mean ± SD	Mean ± SD
Right ear	TEH (cm)	5.83 ± 0.42	5.97 ± 0.35	6.10 ± 0.35
	EW (cm)	2.94 ± 0.23	2.96 ± 0.22	3.12 ± 0.22
	LH (cm)	1.64 ± 0.23	1.69 ± 0.21	1.171 ± 0.26
	LW (cm)	1.92 ± 0.18	1.97 ± 0.22	1.99 ± 0.26
Left ears	TEH (cm)	5.83 ± 0.40	5.96 ± 0.33	6.20 ± 0.24
	EW (cm)	2.93 ± 0.26	2.99 ± 0.31	3.14 ± 0.24
	LH (cm)	1.67 ± 0.21	1.71 ± 0.18	1.74 ± 0.28
	LW (cm)	1.95 ± 0.22	1.95 ± 0.23	1.99 ± 0.28
SD : Standard deviation ; TEH : Total ear height; EW : Ear Width; LH : Lobular Height; LW : Lobular width				

The mean of TEH, EW, LH, and LW were found to be increasing with advancing age in both the sexes. According to Table 2, all parameters value are more in left ear than right but not significant statistically. Although all the measurements were higher more in males than in females on both sides, TEH and EW were found to be significantly greater ($p < 0.001$) (Table 3).

Table 2: Right and Left Ear Measurement and Comparison of the Results.

Measurement		Males (n = 93)		Females (n = 84)		Combined (n = 177)	
		Mean ± SD	p value	Mean ± SD	p value	Mean ± SD	p value
Ear height	Right	6.04 ±	0.681	5.74 ±	0.307	5.90 ± 0.40	0.645

		0.36		0.38			
	Left	6.03 ± 0.33		5.77 ± 0.38		5.91 ± 0.38	
Ear Width	Right	3.02 ±0.21	0.098	2.88 ± 0.22	0.595	2.95 ± 0.23	0.489
	Left	3.06 ± 0.25		2.87 ± 0.25		2.97 ± 0.28	
Lobule Height	Right	1.67 ± 0.20	0.040	1.66 ± 0.24	0.375	1.66 ± 0.22	0.042
	Left	1.69 ± 0.20		1.68 ± 0.21		1.69 ± 0.21	
Lobule Width	Right	1.96 ± 0.20	0.671	1.92 ± 0.21	0.325	1.94 ± 0.21	0.294
	Left	1.96 ± 0.23		1.95 ± 0.22		1.96 ± 0.23	
Ear Index	Right	50.21 ± 3.88	0.135	50.26 ± 4.09	0.355	50.23 ± 3.97	0.840
	Left	50.75 ± 3.92		49.79 ± 4.75		50.30 ± 4.35	
Lobule Index	Right	119.07 ± 14.60	0.269	117.33 ± 19.28	0.831	118.25 ± 16.95	0.391
	Left	117.33 ± 16.70		116.86 ± 15.01		117.11 ± 15.87	

P - value calculated using paired samples t-test.

SD : Standard deviation.

Table 3: Comparison of the Measurements According to Gender (n = 177)

Measurements	Male (n = 93) Mean ± SD	Female (n = 84) Mean ± SD	p value
Right ear height	6.04 ± 0.36	5.74 ± 0.38	0.000
Right ear width	3.02 ±0.21	2.88 ± 0.22	0.000
Right lobute height	1.67 ± 0.20	1.66 ± 0.24	0.850
Right lobute width	1.96 ± 0.20	1.92 ± 0.21	0.269
Right ear index	50.21 ± 3.88	50.26 ± 4.09	0.934
Right lobute index	119.07 ± 14.60	117.33 ± 19.28	0.476
Left ear height	6.03 ± 0.33	5.77 ± 0.38	0.000
Left ear width	3.06 ± 0.25	2.87 ± 0.28	0.000
Left lobute height	1.69 ± 0.20	1.68 ± 0.21	0.792
Left lobute width	1.96 ± 0.23	1.95 ± 0.22	0.645
Left ear index	50.75 ± 3.92	49.79 ± 4.75	0.141
Left lobute index	117.33 ± 16.70	116.86 ± 15.01	0906
p- Value calculated independent samples t-test. SD : Standard deviation.			

The left ear indices were found to be higher than the right ones for all the subjects but in females subjects, the right indices were found to be greater than the left ones. No significant different was found in the ear index of males and females. The right lobular indices were found to be higher than the left ones for all the subject (Table 2).

Discussion

The TEH is important in the evaluation of congenital anomalies (Down Syndrome). The ear reaches its mature height at 13 year in males and at 12 years in females. McKineey et al study addressed specifically the treatment of the ear and earlobe in esthetic surgery and obtained data from 100 normal volunteers and found a mean ear height of 6.50 cm and a mean LH of 1.80 cm, with no significant correlation between the earlobe height and aging. In a study consisting of North American Whites, its was observed that the total height of the left ear was 62.4 mm in men and 58.5 mm in women, and that the same measurement was 70.1 mm in Japanese people. Also according to the study by Barut and Aktunc, the mean height of the ears on both sides was significantly higher in males than in females.

Among the craniofacial syndromes, disproportionately wide ears are observed mostly in Apert and Crouzon syndromes and narrow ears mostly in cleft lip and palate patients. The mature width of the ear is achieved in males at 7 year and in females at 6 years. A study consisting of 100 males and 100 females found the EW to be 32.4 mm for the left ear and

33 mm for the right ear in women. However, Della Croce et al reported the EW to be 30.5 mm. The results of Bozkir et al showed 33.3 mm for the left ear and 33.1 mm for the right ear of 191 young men, as compared with 31.3 mm for the left ear and 31.2 mm for the right ear of 150 young women. In our study, the EW in males for the righ ear is 3.02 cm and left ear is 2.87 cm. when our results are compared with literature findings, more or less same values of EW are found. In our study, a statistically significant difference is found in the mean width of ear in males and females and it is higher in males ($p < 0.001$). Kalcioglu et al found no statistically significant differences in the mean width of ears between males and females from 15 to 19 different age groups. Farkas et al found that male subjects had wider ears than those of female subjects. But did not mention any statistically significance.

An acquired deformity that develops with aging may include elongation or ptosis of the ear lobe. This condition has been attributed to the loss of elastic fibers and gravitational forces. Earnings are an additional weight on the ears, and an average LH to be 1.88 cm and an increase in LH for both sexes. The LH in our study is 1.69 cm in young women. The LH is our study is 1.69 cm in young men and 1.68 cm in young women. The value are more in males and increase with age. We also explained that the increase in the LH with age is no due to the weight effect of earrings since the majority of the women and none of the men has pierced earlobes in our cohort. These measurements suggest that the lengthening of the ear lobe is likely to be the result of the aging process. In esthetic earlobe reconstruction, the primary aim is to be achieve a more youthful appearance. Therefore, our study group consisted of young adults.

In the analysis of data with regard to sex it was observed that the ear lobe size did not vary significantly between the men and women.. The breadth of ear lobule increased up to the age of 15 years, nearest 0.1 mm. Almost static between 16 years and 40 years, increased again from 41 years onward in our study, LW is cm in males and 1.95 cm in females and supports other's studies. When we compare our study with those of other, we find that there is a difference in the values of ear measurements, and these discrepancies could be a result of factor such as race, genetic variables, individual constitution, environment, age, and human error. With regard to the sex difference showed the TEH and EW were significantly higher in men as compared to other measurements.

Conclusion

This study provides the mean values of the different morphometric measurements of the left and right ears. The data presented in this study have yielded parameters for ear anomalies and variation, and may help plastic surgeons to reproduce an anatomically correct ear during its reconstruction.

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