Original Article

Correlation between Size of Pinna & Height of Individual in Uttar Pradesh Population

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Abstract

Introduction: Morphometry of ear is a useful tool for the determination of height & other parameters of individual. The size of the pinna has been measured by some workers for designing hearing aids. No available literature on the study of correlation between the height of an individual and the size of pinna in different age and ethnic groups were available. In this study the height   of the individual along with age and size of the pinna was measured in order to find out possible correlation in adult North Indian population. It was anticipated that a possible correlation could help in identification of different ethnic groups. **Subjects and Methods**: A study was conducted on 167 subjects including both males and females. The height of the individual was measured with the help of an anthropometric rod. The measurements related to total ear length & ear width and lobule length & width were taken with a digital Vernier Caliper & the height of the individual was measured using stadiometer & transparent graduated ruler. The pearson correlation were used to establish relationship. The data was analysed using SPSS version & $p<0.05$ was significant. **Results:** There was no difference between the size of the right and left pinna. The length of the pinna was 62.45 ± 4.21 to 62.35 ± 4.12mm and the width was 24.59 ± 2.41 to 24.63 ± 2.41mm. The length of the lobule varied between to 19.21 ± 2.75 to 19.19 ± 2.75mm and the lobule width was 20.14 ± 2.54 to 20.10 ± 2.56mm of both right and left pinna. In present study there was a significant correlation between rt ear length & width with the height of the individual. Similarly Rt lobule length, Lt lobule length & width also has significant correlation with height of individual. **Conclusion:** The present study reveals that the ear morphometry is an additional tool in prediction height from linear ear dimensions.

Keywords: Morphometry, Ear lobule, Ear height and Human auricle.

Introduction

Morphometric measurements of different parts of the body have been used in determining the sex, age, racial characteristics, designing of prosthesis etc since for a long time. Some measurements have been extensively used while the others have not been analyzed frequently. Human ear is a defining feature of the face as structures   in it convey signs of age and gender.[1] The auricle reaches its mature height at 13 yrs in male & 12 yrs in female so its known that size of auricle increases after completion of development.[2] The human ear is divided into external, middle and internal parts. The pinna and the 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.[3] The anatomical structures of the external ear are utilized for personal identification of living subjects in relation to criminal activity. There have been claims in recent years that the external ear may be utilized for personal identification of both living and deceased individuals.[4] So, knowledge about normal auricular dimensions is important in diagnosis of congenital malformation   syndromes & acquired deformities.   The most famous work among ear identification is made by Alfred Iannarelli in 1989,[5] on 10000, ears and found that all ear were different but   no attempt has been made by these authors to correlate the measurement different parts of the ear with the height of individual. Anthropometric data vary for individuals within a family or nation and between nations noted by Roebuck et. al.[6] similarly Saha,[7] also observed that there were difference in morphometric data of people from different regions in India. In this study we have measured the size of the pinna and lobule and tried to ascertain any correlation between size of the pinna and height of individual. This study is a preliminary report to describe the total pinna length and width in relation to height of a individual amongst adult North Indians (Aged 18 to 60 years). These morphometric   data   envisaged   that   anatomical   and morphological differences and changes of the ear in relation to height of individual. With the appropriate normative data, it is hoped that better objective reference material would be provided for the aesthetic plastic surgeon, Forensic purpose,

in particularly those engaged in ear rejuvenation in the country.

Subjects and Methods

This study was carried out on north Indian population from West Uttar Pradesh, in the age group of 18-60 years including 167 Males & 33 females. A written consent was obtained from each participant in a prescribed format. Each participant was informed of the nature of the study before obtaining the consent. Healthy individuals in age group of the 18-60 years, without any deformity or abnormality & willingness to participate are included in the study. Age group below 18 and above 65 years of age, having any type of physical deformity or ear injury were excluded from the study. The height of the individual was measured with the help of an anthropometric rod. The measurements were taken from the vertex of the head to the ground [Figure 1].The age of the individual is also taken.

Figure 1: Person standing in front of the anthropometric ROD

Technique: - Using the Rod, the subject was made to stand barefoot on the floor. Both feet were in close contact with each other and head oriented in Frankfurt's plane. The height was recorded in centimeters.

Measurement of ear length & width:-

The measurements related to total ear length & ear width and lobule length & width were taken with a digital Vernier Caliper [Figure 2].

The observations were made according to the methods of D.E.O Eboh (2013).[8] Each subject was made to sit in a natural head position in a chair with a backrest and positioned in such a way so that the eyes of the subject looks straight forward with the lower border of the eye sockets in the same horizontal plane as the external auditory meatuses. Four parameters were measured on each of right and left ears- the total ear length, total ear width and total lobule

length, total lobule width were measured. Total ear length [was measured as the distance from the most superior point of the helix (A) to most inferior point of the ear lobule (B). Total ear width was determined by measuring along the broadest part of the pinna from the (D) to (C) as shown in [Figure 3].

Figure 2: Digital Vernier Caliper

Figure 3: Left pinna showing the total length A to B and ear width from C to D.

Total lobule length was taken as the distance from the tip of anti-tragus (E) to most inferior point of the lobule (B) and the total lobule width was measured as horizontal distance of the lobule at the midpoint of the lobule length (EB) in [Figure 4].

Table 1: Summary of parameters taken in the study

Parameters	Range	Mean
Age (years)	18 - 57 years	31.36±8.89
Height (cm)	150 -188	167.41±8.43
REL (mm)	52.28-76.35	62.45±4.21
LEL (mm)	52.28-73.51	62.35±4.12
REW (mm)	15.73-31.48	24.59±2.41
LEW (mm)	15.73-31.03	24.63±2.41
RLL (mm)	13.53-28.61	19.21±2.75
LLL (mm)	13.54-28.61	19.19±2.75
RLW (mm)	14.18-27.34	20.14±2.54
LLW (mm)	14.18-27.34	20.10±2.56

REL – right ear length; LEL- left ear length;
REW right ear width; LEW-left ear width
RLL-right lobule length; LLL- left lobule width
RLW- right lobule width; LLW left lobule width

Figure 4: left pinna lobule showing the total length E to B and lobule width from F to G.

All the measurements were taken by digital venire caliper with an accuracy of 0.001 and recorded in millimeters (mm) in a data sheet. And height of individual was measurement in centimeters. Then the size of pinna and lobule will be compared on the right and left side. Then the height of the individual and the average length and width of the pinna was correlated.

The subjects were divided in 8 groups according to their height at a interval of 5 cm. Readings were statistically analyzed in order to determine the relationship between the size of the pinna and the height of the individual. The data were expressed as mean, standard deviation & pearson correlation.

Results

The pinna of 167 subjects were measured in the age group of 18 – 57 years. The readings are summarized in Table 1. The average height of individual varies from 150-188cm. there was no difference between the size of the right and left pinna. The length of the pinna was 62.45±4.21 to 62.35±4.12mm, and the width was 24.59±2.41 to 24.63±2.41mm. The length of the lobule varied between to 19.21±2.75 to 19.19±2.75mm and the lobule width was 20.14±2.54 to 20.10±2.56mm of both right and left pinna.

Table 2: Different morphometric measurements of pinna in relation to height.

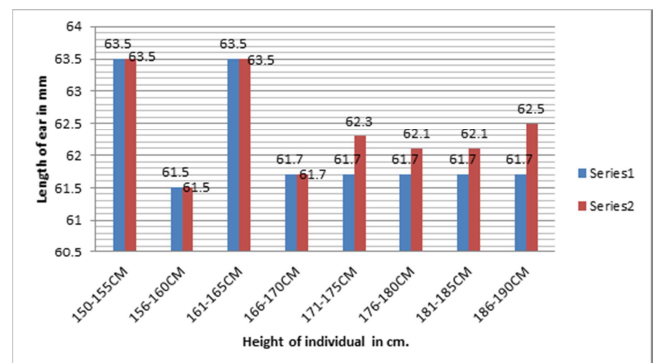| Group	Number of subjects	Mean Height in cm.	Mean pinna length in mm.		Mean ear width in mm.	
			Right	Left	Right	Left
A	114	166.89	61.58±3.86	61.47±3.8	24.41±2.51	24.53±2.4
B	54	167.02	63.23±4.68	63.18±4.45	24.72±2.36	24.71±2.43
C	24	170	64.15±4.23	64.02±4.31	24.63±2.25	24.6±2.6
D	8	169.63	64.36±2.59	64.36±2.59	25.7±1.75	25.7±1.75

Figure 5: A bar diagram showing the relation between the length of pinna with height of individual. Series-1 Mean length of ear, Series-2 Mean height of the individual.

This table shows there is slight increase in length of pinna with increase in height but there is no significant correlation between pinna lengths on RT & LT ear.

Table 3: showing the Relationship between height of individual and length of pinna

Group	Height in cm.	Number of subjects	Mean pinna length		P-value	Conclusion
			Right	Left		
A	150-155	20	63.37±5.4	63.5±5.3	0.93	Insignificant
B	156-160	22	61.67±4.5	61.5±4.1	0.89	Insignificant
C	161-165	37	63.6±5.5	63.5±4.99	0.93	Insignificant
D	166-170	59	61.71±3.5	61.7±3.38	0.98	Insignificant
E	171-175	31	62.51±3.2	62.3±3.06	0.79	Insignificant
F	176-180	22	62.44±4.1	62.1±4.13	0.78	Insignificant
G	181-185	6	62.44±3.6	62.1±3.11	0.86	Insignificant
H	186-190	3	62.53±2.8	62.5±2.77	0.99	Insignificant

Table 4: showing the Relationship between height of individual and width of pinna.

Group	Height in cm	No. of Subjects	Mean pinna length		P-value	Conclusion
			Right	Left		
A	150-155	20	25.81 ±2	25.93±2.04	0.85	Insignificant
B	156-160	22	24.71±2.5	24.38±2.21	0.64	Insignificant
C	161-165	37	25.28±2.2	25.36±3.24	0.86	Insignificant
D	166-170	59	24.16±2.2	24.4±2.09	054	Insignificant
E	171-175	31	23.89±1.8	23.8±2	0.85	Insignificant
F	176-180	22	24.56±2	24.45±2.09	0.85	Insignificant
G	181-185	6	24.41±1.2	24.74±1.2	0.64	Insignificant
H	186-190	3	23.35±1	23.35±1	1.0	Insignificant

This table shows mean width of pinna on RT &LT ear along with height of individual showing no correlation .

Table 5: Different morphometric measurements of lobule length in relation to height.

| Group	Height (cm)	Number of subjects	Mean lobule length in mm		Mean lobule width in mm.	
			Right	Left	Right	Left
A	150-155	20	19.22±3.08	19.04±3.05	18.62±2.82	18.62±2.81
B	156-160	22	18.09±2.35	17.86±2.82	18.47±1.88	18.53±2.2
C	161-165	37	19.31±2.26	19.43±2.74	20.33±2.5	20.06±2.4
D	166-170	59	19.14±2.56	19.41±2.65	20.03±2.72	20.03±2.22
E	171-175	31	19.46±2.92	19.41±2.92	21.32±2.24	21.25±2.24
F	176-180	22	19.35±2.52	19.5±2.69	21.13±2.6	21.26±2.72
G	181-185	6	19.49±2.94	19.25±2.7	21.53±1.68	21.53±1.68
H	186-190	3	18.32±1.15	18.8±0.47	20.95±2.52	19.75±1.96
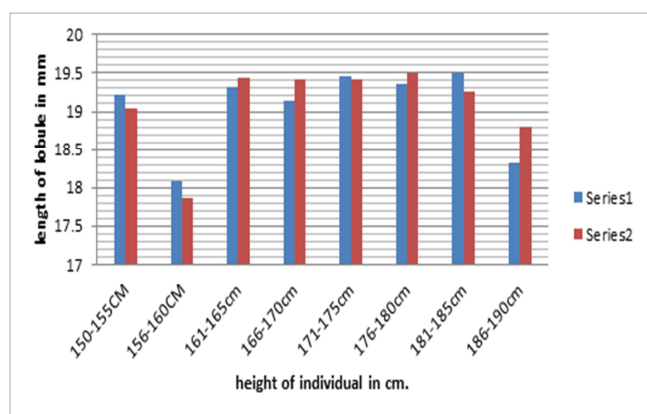
Figure 6: Bar diagram showing the relation between the length of lobule with height of individual.

Series-1 Mean length of right lobule, S   series-2 Mean length of left lobule.

Table 6:Showing correlation of ear dimensions with height of the individual

Height (cm)	Total Ear Length in (mm)		Total Ear Width in (mm)		Lobular Length in (mm)		Lobular Width in (mm)	
	Right	Left	Right	Left	Right	Left	Right	Left
Correlation (r)	0.464	0.055	.0185	0.147	0.106	0.141	0.189	0.152
p- value	0.001	0.440	0.009	0.041	0.103	0.046	0.008	0.031
Conclusion	S	NS	S	S	NS	S	S	S

This table shows that ear dimensions are increasing with height of individual but not significantly.

Discussion

Morphometric measurements play an important role in plastic surgery, prosthetics, industrial designing, clothing designing, ergonomics, architecture and forensic sciences.

This morphomeric data provides a valuable source of information to ergonomists and designers who attempt to consider a range of body sizes and abilities in the design of occupational environments and products. The available literature on the size of pinna does not show any correlation between the height of individual and size of the pinna. Most of workers have measured the size of the pinna and lobule in different ethnic groups. The present study is a correlation between Size of Pinna and height of individual in Indian Population. Van der Lugt C,[9] measured ear length, ear width, length of the lobule, width of the lobule, distance between the tragus and the anti-tragus and correlated with different parameters similar to our study. GulhalBozkir et al.[10] studied morphological features of external ear in 341 young male & female and reported that size of pinna in males are higher than females but in our study size of Rt &Lt pinna in both males and females are same.

Oludiran OO et al.[11] did study on morphometry of external ear on 1462 nigerian between age 8-30 yrs found that rt & lt ear length was 58.6 ± 5.2 mm, 58.5 ± 4.9. rt &lt ear width was 33.4 ± 4.8 & 34.0 ± 4.9mm. Lt &Rt lobular length was 15.8 ± 3.3 & 15.9 ± 3.6mm & lobular width was 17.2 ± 4.1 mm & 17.2 ± 4.3 mm while in present study in length of the pinna was 62.45 ± 4.21 to 62.35 ± 4.12mm, and the width was 24.59 ± 2.41 to 24.63 ± 2.41mm. The length of the lobule varied between to 19.21 ± 2.75 to 19.19 ± 2.75mm and the lobule width was 20.14 ± 2.54 to 20.10 ± 2.56mm of both right and left pinna. In his study by Oludiran OO showed that there is no significant correlation between RT & LT ear similar to our study.

Sadacharan CM et al.[12] done Ear Morphometry study on Indian ,Americans and its clinical importance in 100 Indian American subjects observed that the total length of right and left side ear was 60.27 ± 8.46 mm, 60.29 ± 8.61 mm, ear width right and left side was 32.04 ± 04 mm, 32.25 ± 7.19 mm which are similar to our findings.

Taura GM et al.[13] done Height Prediction from dimensions of external ear on 219 subjects consisting of 137 males and

82 females, measured three parameters of both side pinna in each subjects, total ear length, ear width and ear index and height of subjects. In this study he reported that the correlation higher with height in right ear width and least found in left ear index. All the measurements were insignificant in height prediction except right ear width and left ear index. The mean of right ear length was 60.31mm and left was 59.95mm, right ear width which are same as in our study. In present study it was found significant correlation between rt ear length & width with the height of the individual. RT lobule length, LT lobule length & width has also significant correlation with height of individual.

Signal J et al.[14] in his study on Auricle Morphology for identification in Indian among 400 students showed that the mean observation of the right and left ear length of males were 4.61±0.41 cm, 4.54±0.44cm which was less as compared to our study.

Conclusion

Knowledge about the normal auricular dimensions is important in the diagnosis of congenital malformation, syndromes & acquired malformation. Thus the data presented in our study yielded parameters for ear anamolies & variations & help plastic surgeons to reproduce anatomically correct ear during its construction. The present study also reveal that the potential of ear morphometry is an additional tool in predicting height by using simple invasive techniques. Therefore, it is concluded further study was required to provide different formula for prediction of height from ear dimensions.

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