

A Morphometric Study of External Ear from Perception of Forensic Science

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ABSTRACT

The human ear is separated into external, middle and internal parts. The pinna along with the external acoustic meatus constitutes the external ear. The measurements of the external ear are employed in forensic investigation in recognizing gender and ethnicity in human population. The analysis from the present study showed a higher mean total ear height of 5.74 ± 0.047 in males than females. However, when compared in males the height is more in left ear than right. The Malays are having a larger ear than other two races in Malaysian population. The conclusion of this study disclosed a variance in dimensions in indices of the external ear.

Keywords

External ear; gender, Morphometric, dimension; ethnicity, forensic science.

Introduction

The term Anthropometry are referred as the measurement of the living human body dimensions for the purpose of understanding human physical variation as it plays an important role in plastic surgery, prosthetics and for data collection. The statistical data regarding the distribution of body dimensions among the population are useful for apparel sizing, forensic studies and optimize products. Many studies have defined human body parts and their proportions to each other morphometric measurement¹. The ear is defining feature of the face and its structure shows the sign of age and sex of a person. Mainly, the human ear is divided into 3 parts which is external, middle and internal parts. Pinna and external acoustic meatus form the external ear². The auricle contains osseous cartilaginous external acoustic meatus extends inwards from the auricle to the tympanic membrane. There is a yellow elastic cartilaginous folding that gives the characteristic configuration to the Pinna; whereas the lobule is the inferior part of pinna. It contains only fibro-fatty tissue that covered by cutaneous fold³. The consequences of hereditary diseases or injuries such as trauma, infections or excision of tumour are the causes of malformations of the external ear. This condition requires surgical intervention or prosthetic replacement⁴. Meanwhile, in plastic surgery, require detailed information regarding its complex morphology and the normal dimensions to construct and precisely to determine the position and the orientation of the auricular framework⁵. The jurisprudence requires an opinion regarding personal identification of the deceased when there is crime or discovery of unidentified human corpse⁶. The Malaysian data is very less in terms of parameters of dimensions of external ear. The numbers of studies conducted are limited. The morphometric analysis of indices of external ear is required in authorizing age and gender and ethnicity in forensic investigation. The focus of this study is to enlighten quantification and differentiation of various dimensions of external ear highlighting its importance and sensibility towards forensic investigation.

Methodology

This is a cross-sectional study. It is carried out on 151 volunteers with no evidence of congenital ear anomalies or previous ear surgeries, the volunteers were selected randomly from a private Medical University in Klang Valley, Selangor, Malaysia. The study cohort consisted of 75 males and 76 females, aged 18 to 30 years old. Age and gender were recorded from each volunteer. Informed consent were given and obtained from each volunteer before the doing the measurements. The indices of the external ear are estimated with verniercaliper in both right and left ear. 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. The TEH was measured as the distance from the most inferior projection of the ear lobule to the most superior projection of the helix. The EW is measured as the distance between the most anterior and posterior points of the ear. The LW is measured as the transverse or horizontal width of the lobule.

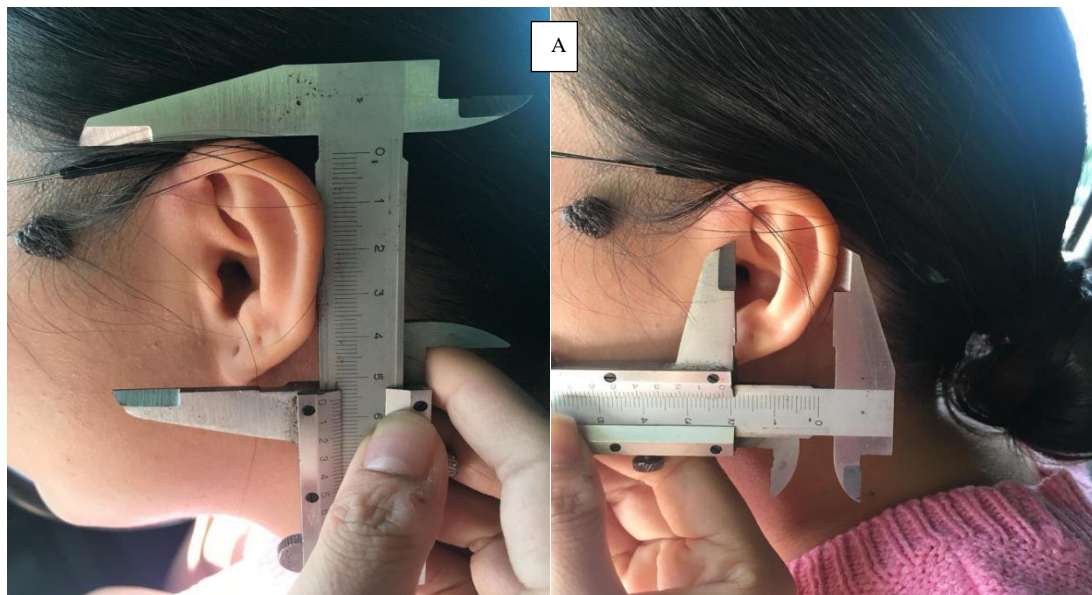


Figure 1 (A) Measurement of total ear Height (TEH) (B) Measurement of Ear width



Figure 2 (A) Measurement of Lobule Height (LH) (B) Measurement of Lobule width (LW)

Result

Table 1.1 showing the measurement of different indices of external ear in gender

| Measurement | | Male (n=75) | | Female(n=76) | | Combined | |
|------------------|-------|--------------------|---------|--------------------|---------|--------------------|---------|
| | | Mean \pm SD (cm) | P value | Mean \pm SD (cm) | P value | Mean \pm SD (cm) | P value |
| Total Ear height | Right | 5.74 \pm 0.47 | 0.001 | 5.50 \pm 0.34 | 0.000 | 5.61 \pm 0.43 | 0.000 |
| | Left | 5.82 \pm 0.48 | | 5.55 \pm 0.36 | | 5.69 \pm 0.44 | |
| Ear width | Right | 2.65 \pm 0.37 | 0.001 | 2.41 \pm 0.34 | 0.003 | 2.53 \pm 0.37 | 0.000 |
| | Left | 2.70 \pm 0.57 | | 2.50 \pm 0.31 | | 2.60 \pm 0.47 | |
| Lobule height | Right | 2.14 \pm 0.32 | 0.000 | 2.04 \pm 0.25 | 0.000 | 2.09 \pm 0.28 | 0.000 |
| | Left | 2.06 \pm 0.33 | | 2.26 \pm 0.65 | | 2.07 \pm 0.49 | |
| Lobule width | Right | 2.17 \pm 0.50 | 0.163 | 2.01 \pm 0.38 | 0.000 | 2.09 \pm 0.45 | 0.000 |
| | Left | 2.01 \pm 0.47 | | 2.03 \pm 0.41 | | 2.12 \pm 0.44 | |

The mean value of right ear height 5.74 ± 0.47 of male is slightly more than in females. The analysis exhibited an increase width 2.65 ± 0.37 of the right ear in males than in females. It is same for the analysis of lobule height (2.14 ± 0.32), lobule width (2.17 ± 0.50) in the right of males compared to females. The measurement in the left side exhibited an increase in ear height, ear width in right side of males than females. However, the lobular height (2.26 ± 0.65) and lobular width (2.03 ± 0.41) is more in females than in males. The quantification of data in all the parts showed a P value less than 0.05 except the lobular width which is statistically non-significant. The combine analysis exhibits a higher ear height with a mean value of 5.69 ± 0.44 in left side than right. Ear width also shows a slightly increased mean value of 2.60 ± 0.47 in left ear

than right. The lobule height and lobule width appear almost same in their mean values. The combine estimation of all indices of the external ear reveals significance with P value less than 0.05.

Table 2 Showing the analysis of external ear in different races in Malaysian population.

| | Malay (n=61) Mean \pm SD (cm) | Chinese (n=52) Mean \pm SD (cm) | Indian (n=37) Mean \pm SD (cm) | P value |
|----------------------------|---|---|--|----------------|
| Right ear height | 5.31 \pm 0.47 | 5.76 \pm 0.34 | 5.23 \pm 0.32 | 0.00 |
| Right ear width | 2.45 \pm 0.37 | 2.43 \pm 0.33 | 2.44 \pm 0.31 | 0.00 |
| Right lobule height | 2.16 \pm 0.32 | 2.02 \pm 0.25 | 2.18 \pm 0.32 | 0.00 |
| Right lobule width | 2.17 \pm 0.50 | 2.01 \pm 0.38 | 2.27 \pm 0.40 | 0.00 |
| Left ear height | 5.80 \pm 0.46 | 5.60 \pm 0.36 | 5.45 \pm 0.34 | 0.00 |
| Left ear width | 2.70 \pm 0.57 | 2.50 \pm 0.31 | 2.63 \pm 0.30 | 0.00 |
| Left lobule height | 2.06 \pm 0.33 | 2.26 \pm 0.65 | 2.30 \pm 0.61 | 0.16 |
| Left lobule width | 2.04 \pm 0.50 | 2.02 \pm 0.39 | 2.03 \pm 0.41 | 0.02 |

Among different races in Malaysian population mean value of 5.76 \pm 0.34 is recorded for the ear height in right side in Chinese which is higher in comparison to Malays (5.31 \pm 0.47) and Indians (5.23 \pm 0.32). The evaluation of right ear width exhibited a value of 2.45 \pm 0.37 in Malays, in Chinese 2.43 \pm 0.33 and in Indians 2.44 \pm 0.31. The width is very similar in all the Malaysian races. The mean right sided lobule height is more in Indians (2.18 \pm 0.32) compared to Malays (2.16 \pm 0.32) and Chinese (2.02 \pm 0.25) and Indians. The right sided lobule width of 2.27 \pm 0.40 is recorded in Indians which is higher than Chinese and Malays. In the left side the mean ear height is highest in Malays 5.80 \pm 0.46 compared to Chinese (5.60 \pm 0.36) and Indians (5.45 \pm 0.34). The mean ear width left side is also more in Malays (2.70 \pm 0.57) compared to Chinese (2.50 \pm 0.31) and Indians (2.63 \pm 0.30). The mean lobular height is more in Chinese (2.26 \pm 0.65) than Malays (2.06 \pm 0.33) and Indians (2.30 \pm 0.61). The Malays are recorded with mean lobular width of 2.04 \pm 0.50, Chinese (2.02 \pm 0.39) and Indians (2.03 \pm 0.41). The analysis of data in all the indices of the external ear showed a significance with P value less than 0.05 except the left lobular width.

Discussion

The human ear is basically an important and under recognized defining the feature of an individual's face. Its shapes able to convey information about age and gender that is clear yet difficult to characterize. In this study a statistical significance result is evidenced from the analysis of the accumulated data in different gender of Malaysian population. The finding of this study is similar with a previous research on external ear ⁷. There are many other studies that evidenced significant difference in various indices of the external ear among genders ^{8, 9, 10, 11}. In this study the ear height and ear width are recorded more in the right ear in both males and females whereas the lobule height and lobule width are higher in left side in both the genders. However, a earlier study reported an increase dimensions in the right ear compared to left ear ¹². There are also several studies which also show a bigger left ear than the right ^{13, 14, 15}. The findings of this research are different from the studies perform earlier. However, there are similarities seen and recorded in between different tribes and races in previous research. One of

the previous study discovered similarity in the indices of the external ear between Onge tribe of Andhra Pradesh in India and Newar tribes of Nepal ¹⁶. The abnormality of the external ear remains as an early diagnostic feature associated with an anomaly of urinary tract. This is due to concomitant origin of external ear and urinary tract during embryogenesis ¹⁷. An early study on parameters of the external ear in neonates evidenced a shorter ears in Negros compared to Caucasians ¹⁸. In current study the dimensions illustrate a larger right ear in Malays compared to Chinese and Indians. But the ear height is seen to be more in Chinese than other two races. The dimensions of the external ear illuminates and emphasizes on quantification of records helping in recognizing various types of ear in forensic investigations enlightening evolutionary and variance in ethnicity.

Conclusion

The study has discovered increased dimensions of the external ear in the right ear of males in Malaysian population. It has also notified a larger ear in Malay race compare to Chinese and Indians. The study will prove and put an indent on the element and diversity on the analysis by quantifying the indices of the external ear. The variance from the estimation will provide a concept of understanding in Morphometry from forensic medicine outlook to recognize human gender and ethnicity.

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