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ANALYSIS OF THE MORPHOLOGICAL FEATURES OF EARS IN HUMAN IDENTIFICATION– A FORENSIC STUDY

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Abstract – Like fingerprints, ear prints too have been used in Forensic investigation since the nineteen sixties. Earprints are unique and are found in various crime scenes mostly burglaries. Outer portion of human ears are confound structure and offers wide range of versatility between different individuals. The present study was aimed to establish a method using the morphological features of ear by using photographs of ears for the identification.

Keywords: Earprints, Human identification, Forensic science

Introduction: Human ear has a definite structural pattern just like human face. Like fingerprints and lipprints (1) two earprints are not identical and hence they can be utilized in Forensic investigations. The individualization of morphological features of human ears in forensic investigation is dated back to mid 1960s. (2) Hirschi was among the first to recognize the value of earprints for person identification when in 1965 two earprints were among the traces found at the scene of a burglaryin Bienne, Switzerland. (3,4) For the recognition of various factors that makes out an ideal earprint, the investigator must be familiar with the morphology of auricle. (4) An auricle can be defined as an irregular, oblong dermal plica, which embraces the orifice of external auditory meatus. The auricle is almost twice as long as its width and its size vary significantly.(5) The auricle is bent in many directions. Its structure is supported by elastic cartilage. The cartilage skeleton determines most of auricle shape. Only the lower ear-lobe is deprived of cartilage. (5, 6, 7, 8, 9,10) The auricle can be characterized by its location, size and shape, which are peculiar features for each human being.

The human auricle has multiple of uses in the Forensic science owing to its specific qualities i.e. various studies have demonstrated that the shape of human auricle usually does not change throughout the life and this organ is not very much prone to injury.(11) The skin of the auricle is covered with sebaceous substances derived from the sebaceous gland transferred from the hair. Earprints can be defined as a two dimensional impression of ear using oil and waxes when it is pressed on their surfaces.(12) Identification can also be made using ear photograph. The present

study deals with the assessment of ear photographs in human identification. Earprints have various utilities in Forensic sciences.(13) (Table 1) Various methods of collecting ear prints have been described in the literature.(5,6) It primarily includes either physical or chemical method for visualization of prints; other techniques include taking photographs, Collection of imprints by pushing ears against a flat glass slab and taking thermo gram picture of ear.(4,7) For getting three dimensional samples from a individual, Dental resins can be used wherein cotton plug is inserted followed by pouring of resin which then solidifies getting three dimension characteristics of ear. (2,5,6,7)

Materials and Methods

The present study is comprised of 219 medical students (123 boys and 96 girls) age ranging from 18 – 26. A verbal consent was taken before carrying out the research. The study was approved by the ethical committee of our institution. Subjects with any developmental, pathological and surgical history associated with ears were excluded. The subjects were asked to sit on a chair in upright relaxed position in a manner that the vertical axis of pinna was perpendicular to the floor. Canon – EOS 200 D II camera was used to take the photographs using 50 mm 1.8 prime lens with aperture value 5, shutter speed 1/300 and ISO was 100. Two photographs of both right and left ear was taken and subsequently transferred to the computer. The following measurements of landmarks were taken. (Figure 1) High-resolution CTs (HRCT) of the temporal bone were taken to rule out the possibilities of pathology in external ear.(14)

The photographs were imported and analyzed using Adobe Photoshop CS6 software. After the processing of the pictures following measurements were taken depicted in figure 1.

Ear length – Superaurale (A) to Subaurale (B)

- Ear breadth – Preaurale (C) to Postaurale (D)
- Base of the auricle – Preaurale (C) to Inferior most attachment of pinna (E)
- Lobe length – Deepest point on the intertragic notch (F) to lowest point on the free margin of the ear lobe.
- Lobe width – Inferior most attachment of pinna (E) to posterior most point of the ear lobe. (G)

A descriptive analysis including mean and standard deviations for each measurement in males and females was generated. The symmetry of right and left ears (Table 2) and the differences in the ear symmetry between males and females (Table 3 and 4) The male to female differences (sex dimorphism) in the parameters recorded were analysed using a t-test (Table 5). P-values of less than 0.05 were considered to be statistically significant. The statistical analyses were done on SPSS 12.0 software (SPSS Inc., Chicago, Illinois, USA)

Results

The descriptive analysis revealed that the statistics of the ear variables measured and analyzed on both right and left side with the degree of symmetry evaluated using the paired t test. The length of ear ranged from 62.5 – 62.8 (mm), the left ear length was found to be larger than the right ear length and was found to be statistically significant. ($p = 0.002$) (Table 2). The right ear breadth was found to be greater than the left ear breadth and was found to be statistically significant ($p = 0.00$) and ranged from 33.5 – 34.0 mm. The measurement of the base of the auricle revealed that the measurement of the base of the right auricle is greater than its left counterpart ranged from 44.7 to 44.3 (mm) and the difference was found to be statistically significant (Table 2)

The right ear lobe length was found to be larger to that of the left ear ranged from 19.1 to 19.2 mm and the difference was insignificant. The difference between the ear lobe width between right and left ear lobes was found to be insignificant.

Table 3 and 4 depicts the symmetry of ears within the sexes. Table 4 depicts the ear morphometry in subjects and sex dimorphism using t test.

Discussion

An in-depth knowledge of the dimensions and relative position of facial structures in different age, sex and ethnic groups is essential for facial reconstruction, both for surgical and forensic purposes.(15) The anthropometric measurements, including those of the ear, can be done either by direct or indirect methods. Although direct anthropometry is ideal, indirect anthropometric techniques such as photography are also frequently used.(15,16)

Solid knowledge on the variability of earprints left by a single ear is of great importance during both phases. It will allow us to record, store and analyse earprints in such a way that the maximum amount of 'natural' variation is taken into account, without introducing unrealistic variation in prints of one ear. (17) The latter would likely impede the search for diagnostic features. Knowing the extent of intra-individual variability, and recognizing stable features, will aid the design of a classification system capable of distinguishing between intra-individual and inter-individual variability.(16,17)

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Tables and Figures

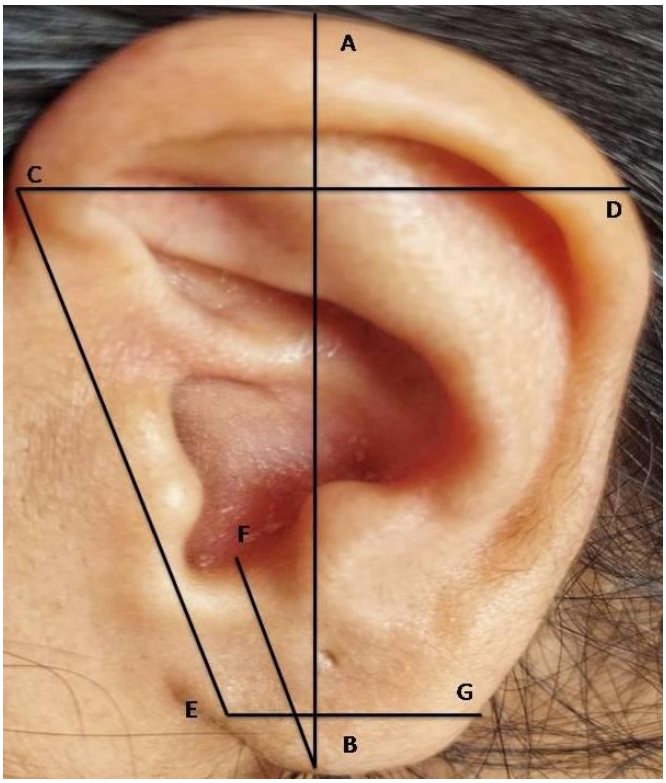

Figure 1. Landmarks used for the ear morphometry

1	When a latent earprint is found on a crime scene can be utilized to exclude a person as a probable suspect.
2	Earprints can be used to dismiss a suspect using transparency overlays to establish the degree of similarity can reveal that person was not responsible for leaving the latent imprint.
3	Earprints can be used to provide further evidence towards a given suspect.
4	A latent earprints can be used on a crime scene when there is no given suspect, a latent earprint can be compared to a database containing earprints gathered from crime scenes.

Table 1. Various scenarios where ear prints can be used in a crime scene.

	Left (n = 219)	Right (n = 219)	Difference	P value
Ear length	62.8 ± 0.51	62.5 ± 0.56	0.03 ± 0.35	0.002
Ear breadth	33.5 ± 0.32	34.0 ± 0.20	0.05 ± 0.25	0.00
Base of auricle	44.3 ± 0.50	44.7 ± 0.33	0.04 ± 0.10	0.00
Lobe length	19.1 ± 0.30	19.2 ± 0.11	0.01 ± 0.15	0.544
Lobe breadth	18.6 ± 0.20	19.0 ± 0.22	0.04 ± 0.10	0.051

Table 2. Descriptive statistics of the measured ear variables (in mm)

Variables	Mean	Difference	T- value	P- value
Left ear length	63.83 ± 4.45	0.05± 4.41	0.115	0.889
Right ear length	63.78 ±5.50			
Left ear breadth	33.05 ± 3.10	1.52 ± 2.95	6.912	0.000
Right ear breadth	34.57 ± 3.30			
Left base of auricle	45.20 ± 5	1.56 1.± 3.10	4.365	0.000
Right base of auricle	46.76 ± 5.85	0.28 ± 1.60	2.080	0.035
Left lobe length	18.77 ± 2.44			
Right lobe length	19.05 ± 2.85			
Left lobe breadth	18.31 ± 3.05	0.64 1.± 2.65	3.558	0.001
Right lobe breadth	18.95 ± 3.10			

Table 3. Symmetry of ear measurements in males using paired t test (in mm)

Variables	Mean	Difference	T- value	P- value
Left ear length	62.43 ± 3.85	1.35± 3.34	3.662	0.009
Right ear length	61.08 ±3.50			
Left ear breadth	32.33 ± 4.10	0.74 ± 2.98	3.612	0.000
Right ear breadth	33.07 ± 2.30			
Left base of auricle	43.20 ± 4.45	1.56 1.± 4.10	2.467	0.000
Right base of auricle	44.76 ± 5.80	0.52 ± 1.70	1.080	0.139
Left lobe length	19.07 ± 2.49			
Right lobe length	18.55 ± 2.85			
Left lobe breadth	18.36 ± 3.05	0.59 1.± 2.77	0.581	0.462
Right lobe breadth	18.95 ± 3.10			

Table 4. Symmetry of ear measurements in males using paired t test (in mm)

	Males		Females		T value	P value
Variables	Mean	Std. dev	Mean	Std. dev		
Left ear length	63.8	0.45	62.4	0.44	4.389	0.000
Right ear length	63.7	0.60	61	0.42	2.012	0.58
Left ear breadth.	33	0.35	32.3	0.33	4.773	0.000
Right ear breadth.	34.5	0.30	33	0.25	5.268	0.001
Left base of auricle	45.2	0.55	43.2	0.45	5.223	0.003
Right base of auricle.	46.7	0.55	44.7	0.44	1.673	0.111
Left lobe length	18.7	0.27	19	0.25	0.223	0.665
Right lobe length.	19	0.30	18.5	0.22	0.389	0.731
Left lobe breadth.	18.3	0.35	18.3	0.33	1.883	0.233
Right lobe breadth.	18.9	0.33	18.5	0.32	1.994	0.001

Table.5 Ear morphometry in subjects studied and sex dimorphism using t – test (in mm)