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MORPHOLOGICAL STUDY OF THE EXTERNAL EAR AMONG THE GENERAL POPULATION IN GHAZIABAD, UTTAR PRADESH: AN IN VIVO STUDY

Dental Science

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ABSTRACT

The human external ear, or auricle, serves a dual purpose: it plays a key role in sound reception and contributes significantly to facial harmony. Its unique shape and dimensions, determined by genetic, environmental, and ethnic factors, have applications beyond hearing—spanning plastic surgery, forensic anthropology, and biometric identification. This cross-sectional observational study examined the morphometric and morphological characteristics of the external ear in 500 healthy adults (250 males and 250 females) in Ghaziabad, Uttar Pradesh, India. Using a digital Vernier caliper, 14 parameters were recorded, including total ear height, lobular dimensions, ear width, projection, and qualitative traits such as ear shape, helix form, lobule attachment, and Darwin's tubercle. Statistical analysis revealed significant sexual dimorphism, with males generally exhibiting larger dimensions than females. Oval ear shape and normally rolled helix were the most prevalent features across both sexes, though earlobe shape, attachment, and Darwin's tubercle varied. The findings establish regional reference data and highlight the value of auricular morphology in clinical, forensic, and ergonomic applications.

KEYWORDS

External Ear Morphology, Morphometry, Sexual Dimorphism, Auricular Anthropometry, Forensic Identification, Ear Asymmetry

INTRODUCTION

Throughout human history, beauty and facial attractiveness have been associated with balanced proportions. The external ear (auricle) is a distinctive facial feature whose structure contributes to overall aesthetics and conveys information about age, sex, and ethnicity. Its complex morphology—consisting of ridges, depressions, and varied contours—arises from embryonic development and genetic inheritance.

Beyond aesthetics, the ear serves practical roles: supporting eyeglasses, directing sound waves into the auditory canal, and, importantly, serving as a soft biometric marker. Like fingerprints, ears possess unique features that remain relatively stable over time, making them useful in forensic investigations, personal identification systems, and anthropological studies.

Historically, Alphonse Bertillon recognized the ear's potential for identification in the late 19th century, incorporating auricular measurements into his anthropometric system. Modern advances, including 3D scanning and biometric algorithms, have strengthened its relevance in security and criminal investigations.

Need for the Study

Although numerous studies have examined ear anomalies, syndromes, and reconstructive techniques, there is a lack of comprehensive data on normal ear morphology in many Indian subpopulations. Such baseline data is critical for:

- Plastic and reconstructive surgery (ensuring symmetrical, proportionate reconstruction)
- Forensic anthropology (human identification when fingerprints or DNA are unavailable)
- Ergonomic product design (e.g., hearing aids, headphones, protective gear)

The goal of this study is to evaluate and compare the variations in shape and dimensions of the right and left external ear in males and females of Ghaziabad, Uttar Pradesh, using a digital Vernier caliper.

MATERIALS AND METHODS

The study was conducted at the Department of Prosthodontics and Crown & Bridge, involving 500 participants (250 males and 250 females) aged 18–45 years. No history of congenital ear anomalies or reconstructive ear surgery, After obtaining informed consent, digital Vernier calipers were used to measure the following parameters:

1. **Total Ear Height:** Distance between highest point of auricle to lowest point of the ear lobe.
2. **Lobular Height:** Distance from intertragic incisure to caudal part of lobule.
3. **Lobular Width:** Horizontal width of lobule at midpoint of maximum lobular height.
4. Distance from tragus to antihelix.
5. Distance from tragus to helix.
6. **Ear Projection:** Distance from helix to processus mastoideus at tragal level.
7. **Ear Width:** Distance between most anterior and posterior points of ear.
8. **Shape of the Ear:** Oval, oblique, rectangular, round and triangular.
9. **Shape of the Helix:** Concave marginal, normally rolled, flat and wide covering scapha.
10. **Shape of the Earlobe:** Arched, tongue, square and triangular
11. **Attachment of the Earlobe:** Attached, Free, partially attached to the skin.
12. **Thickness of the Earlobe:** Medium, thick and thin.
13. **Shape of tragus:** Double knob, single knob and round.
14. **Darwin's Tubercle:** Absent, enlargement, nodosity and projection.

Measurements were documented separately for the right and left ears, and statistical analysis was performed using SPSS software version 23.0. Descriptive statistics, including mean, standard deviation, and frequency distribution, were used to interpret the data. Intergroup comparisons were conducted using independent t-tests, while Chi-square tests were used for ordinal variables.

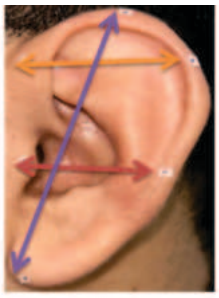
Armamentarium Images

Fig. 1 Digital Vernier Caliper

Fig 2. Surgical Skin Marker

Fig 3. Micropore Tape

Procedure Images



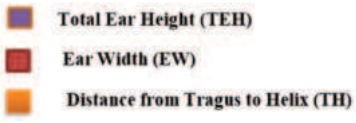
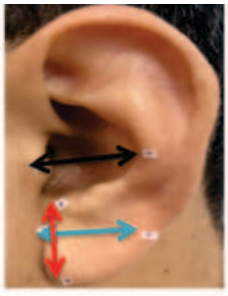


Fig 4. Morphometric Measurements of External Ear



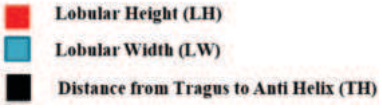


Fig 5. Morphometric Measurements of External Ear

Fig 6. Morphometric Measurements of External Ear

Fig7. Morphometric Characteristics of Ear

- o Shape of Ear
- o Shape of Helix
- o Shape of Ear Lobe
- o Attachment of the Earlobe
- o Thickness of the Ear Lobe
- o Shape of Tragus
- o Darwin's Tubercle

RESULTS

The study identified significant morphological differences between males and females. Key findings include:

- **Size Differences:** Males generally had larger ears and earlobes than females, with statistically significant differences in total ear height and width.
- **Shape Variations:** The oval ear shape was the most common in both sexes, followed by triangular and rectangular shapes.
- **Earlobe Morphology:** The majority of participants had oval earlobes, with females showing a higher frequency of attached earlobes than males.
- **Helix Variability:** The normally rolled helix was the most prevalent, but concave marginal and wide-covering scapha were more common in females than males.
- **Tragus and Darwin's Tubercle:** Males had a higher prevalence of single-knob tragus, while females exhibited more variability in tragus shape. Darwin's tubercle was found more frequently in males, with variations in expression between the right and left ears.

Age-related changes were also observed, with earlobe elongation becoming more prominent over time due to elastic fiber loss and the effects of gravity, particularly among individuals who wore earrings.

DISCUSSION

The ear significantly influences facial aesthetics, revealing age and gender through its unique form. Auricles, though not traditionally considered beautiful, frame the head and contribute to appearance despite minor asymmetries (Rubin et al.)[2]. The external ear consists of the helix– antihelical complex, conchal complex, and lobule[2]. Successful reconstruction requires understanding ear anatomy and variations across age and gender[4].

Morphological studies using tools such as calipers, model casts, laser scanning, and digital imaging allow precise analysis[1]. Total ear height helps detect abnormalities, e.g., smaller ears in Down syndrome; ears typically reach full height by age 13 in males and 12 in females[1,2,7]. In Chinese culture, long ears symbolized longevity and status[2].

Population differences exist: North American males and females average 62.4 mm and 58.5 mm, Turkish 63.1 mm and 59.7 mm, while Japanese ears are slightly larger. This study reported averages of 68.3 mm (males) and 60.6 mm (females), closer to North American and Turkish data[2-4]. With age, ears elongate due to fiber loss and gravity; earrings exacerbate this[6-7]. Earlobe height averages 20.2 mm in young males and 17.6 mm in females; widths are 21 mm and 19.6 mm, respectively[2,4].

Tragus–helix/antihelix distances aid in diagnosing deformities and hearing aid design[2]. This study found male values of 25.3 mm and 19.8 mm, and female values of 24.5 mm and 18.2 mm. Bone-anchored implant success depends on precise placement[2]. Ear projection averages 20.2 mm in males and 18.8 mm in females, aligning with the general 15–20 mm range[2-4].

Syndromes such as Apert and Crouzon are linked to wide ears, while cleft lip/palate patients have narrow ears. Ear width matures by age 7 in males and 6 in females[2-7]. In this study, average widths were 37.3 mm (left) and 36.0 mm (right) for males, and 30.9 mm (left) and 30.3 mm (right) for females, slightly higher than prior reports[2,4,6]. Male ears were consistently larger in both height and width[1,2,4,5,6,7].

Oval-shaped ears were most common (74% males, 61% females). Other shapes included oblique, rectangular, round, and triangular[5]. Bilateral asymmetry was observed in tragus, helix, and earlobe characteristics. Earlobes varied between attached, free, and partially attached; helix forms included concave, rolled, flat, and wide covering scapha[1,3,5,6]. Darwin's tubercle showed variable expression, supporting forensic individualization[5,6].

Genetic studies link ear morphology to EDAR and TBX15 genes, highlighting the need for further population-specific genetic research (Adhikari et al., 2015)[6-8]. Forensically, ear injuries from blunt force, lacerations, bites, gunshots, or blasts provide critical evidence. Age-related changes aid age estimation, while swabs from the ear can yield DNA in assault cases[8].

Overall, the ear contributes significantly to aesthetics and forensic science. Its morphology supports personal identification, injury analysis, and crime reconstruction, particularly when combined with genetics and computer forensics.

CONCLUSION

This study provides a comprehensive analysis of external ear morphology among the general population in Ghaziabad, Uttar Pradesh. The findings establish reference values for ear dimensions, shape variations, and sex-based differences, which can aid in forensic science, plastic surgery, and hearing aid design. Further research involving larger sample sizes and diverse populations is recommended to refine the applicability of these findings across different demographic groups.

Clinical and Forensic Implications

1. Forensic Identification: Ear morphology can serve as a supplementary biometric trait in criminal investigations.
2. Plastic and Reconstructive Surgery: The study provides baseline measurements that can guide surgical reconstruction of congenital and acquired ear deformities.
3. Hearing Aid Design: Understanding variations in ear shape and size can improve the ergonomics and fit of hearing devices.
4. Genetic and Anthropological Research: The observed variations may contribute to studies on genetic inheritance and population diversity.

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