Original Article

Morphologic Variations in External Ear among Ethnic Meiteis: A Hospital-Based Cross-Sectional Study

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Abstract

The external ear is highly individualised in terms of its shape, size, and other morphological characteristics, making it a useful tool for forensic identification in determining sex and personal identification. These characteristics are believed to be controlled by multiple genes and shared among genetically related individuals. To describe the uniqueness and sexual differences in external ear morphology among the ethnic Meiteis, a cross-sectional study was conducted in the Clinical Section of the Department of Forensic Medicine and Toxicology from May 2022 to April 2024. The study included 422 ethnic Meiteis, and common characteristics observed in both sexes included an oval-shaped pinna in 35.38% of individuals, nodosity of Darwin's tubercle in 74.53%, medium-sized anti-tragus in 50.66%, arched shape of the lobule in 44.67%, and proportionate form of the concha in 74.10%. The tragus types were evenly distributed, with an average of 30% for each type. The shape of the helical fold differed between males and females, with 60.03% of males having a normally rolled shape and 62.16% of females having a wide covering scapha shape, with an average occurrence of 49.14%. There was no significant sexual difference in the external ear characteristics except for the helical fold. Regarding the uniqueness, most of the ethnic Meitei population exhibited the nodosity type of Darwin's tubercle, medium-sized anti-tragus, and proportionate form of the concha, accounting for more than half of the total study population.

Keywords: Ear morphology, ethnic Meitei, identification

Introduction

Identification is the establishment of a person's individuality based on specific physical characteristics unique to the individual. In forensic practice, establishing identity becomes challenging in mutilated remains, skeletal remains, and burnt bodies. Many entities, such as bones, teeth, hair, and external peculiarities, have been used for identification purposes. However, there is not enough data for identifying a person based on a single entity alone. Using various entities together provides a foolproof method for determining a person's identity.

The human external ear is considered unique in every individual in shape, size, and other

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morphological characteristics, making it suitable for forensic identification for sex determination and personal identification purposes. Further, various features of the external ear are under multiple genetic controls and are expected to behave similarly in genetically related persons.[1]

The external ear is made up of a single piece of fibrocartilaginous structure with an irregular surface with varying degrees of elevation and depression. It has the most visible external features on its surface compared to the other external features of the face. Further, according to some studies, ears are considered unique to every person to the extent that they are comparable to fingerprints.[2] The present study is being carried out with an objective to describe the morphologic variations in the external ear regarding its uniqueness and sexual dimorphism among ethnic Meiteis. The Meitei ethnic people are located in the state of Manipur. A Meitei individual whose three generations from both mother's and father's side are taken as ethnic Meiteis. No previous studies have been conducted on this ethnic group.

Materials and Methods

This cross-sectional study was conducted in a tertiary care teaching institute in North-East India. The data was collected from cases brought for examination in the Clinical Section of the Department of Forensic Medicine and Toxicology.

The sample size is calculated using the formula-

$$N=(Z_1-\alpha/2)^2pq/d^2,$$

$Z_1-\alpha/2=1.96$ (Critical value for the corresponding level of confidence of 95%)

p= By assuming 50% of the population have oval-shaped pinna[4]

(Based on a previous study by Singh and Purkait, 2009)

q= 1-p

d= 5% (Permissible margin of error with 95% confidence interval with 10% of non-response rate)

N=384+38(10% non-response rate)=422

The calculated sample size is 422

The study participants included the 422 subjects above ten years of age who were brought for medico-legal examination in the centre, as well as those who were brought for age determination for participation in sports and admission into sports academies/ schools during the period of May 2022- April 2024. Any person with ears with an anatomical defect or injury or previous surgery was excluded. The gender-wise variations in the shapes of the pinna, tragus, anti-tragus, lobule, anti-helix concha border, helical fold, and concha & forms of Darwin's tubercle, ear lobule attachment to cheek, and upper helix were studied.

After obtaining ethical clearance and written informed consent from the participants or parent/ LAR (legally authorized representative) along with oral/written assent in the case of child participants, the participants were seated in a pre-designed room with a camera (Canon Digital camera EOS 1500D Zoom lens EF-S 18-55mm, 24.1 Mega Pixels), Tripod stand (DigiTek DTR-495BH) & Digital Camera Flash) fixed on a tripod stand with adequate lighting. If the participant is wearing earring/s, s/he was requested to remove them wherever possible. The head of the subject was oriented in the Frankfort horizontal plane[3]. The camera's focal plane was kept parallel to the longitudinal plane of the external ear so that any protrusion could be negated to get a uniformly aligned image of the subjects. Images of both the ears of the subject were taken from 25 cm. The features of the external ears were categorized as per the classification, '*Somatoscopic characters describing the form of external ear*'[2]. The features of each subject were noted and compared, the findings were recorded & the data was entered using SPSS version 21(Armonk NY: IBM Corp) & the data were summarised in terms of percentage and frequency.

Results

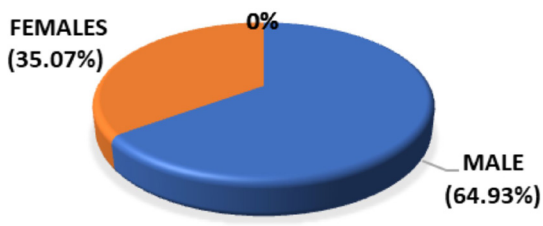

Figure 1: Gender distribution of the participants (N=422)

In this study, out of 422 subjects, 274 (64.93%) were males and 148 (35.07%) were females (Figure 1). The various characteristics of the external ears of both sexes are shown in Table 1. The oval shape (Figure 2a) of the pinna is found to be the most common in both males and females, with an overall percentage of 35.38% in ethnic Meiteis. The nodosity type of Darwin's tubercle (Figure 2b) is seen in both males and females (74.53% of the total study population).

The tragus of the external ear shows almost equal distribution of all three shapes in both males and females. A long type of tragus (Figure 2c) is commonly seen on the right ears of males, and a round tragus (Figure 2d) on the left ears. However, on average, the long types are frequent in males. Interestingly, in the female subjects, the round type of tragus is found to be the commonest.

The medium type of anti-tragus shape (Figure 2e)is the most common in both sexes, with an overall percentage of 50.66%. The distribution of anti-tragus types of the external ear also shows bilaterality in males. The arched-shaped lobule is the most common (Figure 2f) in both males and females with 44.67%. The partial form of lobule attachment to the cheek (Figure 2g) is seen in 44.30%. The shape of concha exhibits high percentages of proportionate type (Figure 2h) in both males and females, with 71.53% and 76.68%, respectively with an average of 74.10% in the ethnic Meitei subjects as shown in Table 1. The upper helix form of the external ear shows acute angle medial form (Figure 2i) in males with 37.22% and 50.67% in females, with an average of 43.94%. The most common anti-helix concha border present iscurved shape (Figure 2j) with 48.72% in males and 45.60% in females. The shape of the helical fold exhibited as normally rolled (Figure 2k) in males (60.03%) and wide-covering scapha (Figure 2l) in females (62.16%).

Table 1: Distribution of the external morphological characters of the ear

Feature	Classification	MALES			FEMALES			Overall
		RIGHT	LEFT	BOTH	RIGHT	LEFT	BOTH	
1. Shape of pinna	1.Oval	35.40%	36.50%	35.30%	35.81%	35.14%	35.47%	35.38%
	2.Round	29.56%	30.66%	29.56%	20.95%	28.38%	24.66%	27.11%
	3.Triangular	14.60%	16.42%	15.23%	17.57%	16.22%	16.89%	16.06%
	4.Rectangular	20.44%	16.42%	18.10%	25.68%	20.27%	22.97%	20.53%
2.Darwin's Tubercle	1.Absent	2.56%	3.65%	3.10%	1.35%	3.38%	2.36%	2.73%
	2.Nodosity	77%	79.93%	78.46%	5.35%	76.35%	70.60%	74.53%
	3.Enlargement	17.88%	13.50%	15.69%	30.42%	17.56%	23.98%	19.83%
	4.Projection	2.56%	2.92%	2.73%	3.38%	2.71%	3.04%	2.02%
3.Tragus	1.Long	42.70%	30.66%	36.67%	34.46%	18.92%	26.68%	31.67%
	2.Round	27.37%	37.96%	32.66%	33.11%	42.57%	37.83%	35.24%
	3.Knob	29.92%	31.39%	30.65%	32.43%	38.51%	35.47%	33.06%
4.Anti-tragus	1.Prominent	28.83%	28.83%	28.83%	33.78%	35.14%	34.45%	31.64%
	2.Medium	54.38%	54.38%	54.37%	45.27%	48.65%	46.95%	50.66%
	3.Flat	16.79%	16.79%	16.78%	20.95%	16.21%	18.58%	17.68%
5.Shape of lobule	1.Triangular	15.33%	14.23%	14.78%	16.22%	14.19%	15.20%	14.99%
	2.Rectangular	29.93%	22.26%	26.09%	30.41%	25%	27.70%	26.89%
	3.Tongue	5.84%	6.93%	6.38%	4.05%	4.73%	4.39%	5.38%
	4.Arched	41.97%	48.91%	45.43%	39.86%	47.96%	43.91%	44.67%
	5.Round	6.93%	7.67%	7.29%	9.46%	8.12%	8.78%	8.03%
6.Lobule attachment to cheek	1.Fully-attached	14.96%	14.60%	14.78%	19.60%	16.90%	18.24%	16.51%
	2.Partial	50.36%	43.07%	46.71%	45.95%	37.83%	41.89%	44.30%
	3.Free	34.68%	42.33%	38.50%	34.45%	45.27%	39.86%	39.18%

Continue.....

7.Concha	1.Narrow	9.85%	9.12%	9.48%	12.84%	5.40%	9.12%	9.30%
	2.Proportionate	74.09%	68.98%	71.53%	72.97%	80.41%	76.68%	74.10%
	3.Broad	16.06%	21.90%	18.97%	14.19%	14.19%	14.18%	16.57%
8.Upper helix form	1.Acute angle medial	33.58%	40.88%	37.22%	47.30%	54.05%	50.67%	43.94%
	2.Angle upper directed	14.96%	10.95%	12.95%	12.84%	8.11%	10.47%	11.71%
	3.Obtuse angle medial	28.83%	30.66%	29.74%	16.90%	20.27%	18.58%	24.16%
	4.Angle laterally directed	13.87%	8.39%	11.13%	10.81%	4.73%	7.77%	9.45%
	5.Obtuse acute angle	5.11%	6.57%	5.83%	5.41%	5.41%	8.78%	7.30%
	6.Double right angle	3.65%	4.01%	3.10%	6.76%	7.43%	7.09%	5.09%
9.Anti-helix concha border	1.Straight	19.34%	18.98%	19.16%	16.22%	14.86%	15.54%	17.35%
	2.Curved	48.91%	48.54%	48.72%	47.97%	43.24%	45.60%	47.16%
	3.Round	24.82%	25.91%	25.36%	26.35%	31.76%	29.05%	27.20%
	4.Laterally protruding	6.94%	6.57%	6.75%	9.46%	10.14%	9.70%	8.22%
10.Helical fold shape	1.Normally rolled	58.76%	61.31%	60.03%	33.11%	35.81%	34.45%	47.24%
	2.Wide covering scapha	37.23%	35.04%	36.13%	62.84%	61.49%	62.16%	49.14%
	3.Flat	4.60%	2.92%	2.91%	3.38%	2.70%	3.04%	2.97%
	4.Concave marginal	1.09%	0.73%	0.91%	0.68%	0%	0.33%	0.62%

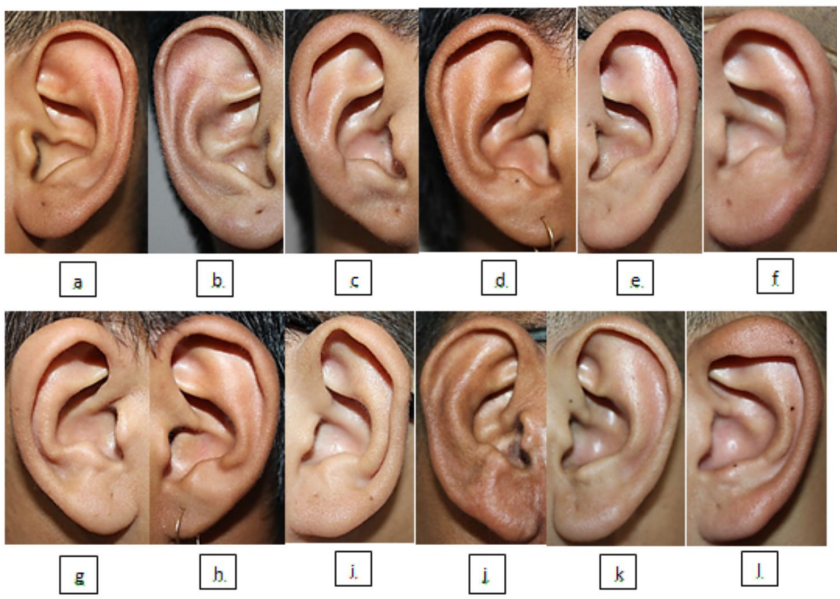

Figure 2: a) Oval shape of pinna b) Nodosity type of Darwin's tubercle c) Long tragus d)Round tragus e) Medium anti-tragus f) Arched lobule g) Partial-attachment of lobule h) Proportionate type of concha i) Acute angle medial form of helix j) Curved shape of anti-helix concha border k) Normally-rolled helix l) Wide-covering scapha

Discussion

In this study, the oval shape of the pinna was the most common in both males and females, while the other types were observed less frequently. Overall, Meitei's ethnicity showed an oval shape, which is the most common, with no sexual dimorphism. Similar findings were seen in a study of the external ear by Singh P et al.[4] in Central India, where oval-shaped pinnae were the most common. Interestingly, in a study by Farhan SS et al.[5] among Iraqi subjects, it was observed that the most common shape of the pinna in females was rectangular (78%). In males, it was oval (64%), and the shape of the pinna showed characteristic sexual dimorphism in the study population. On the other hand, Fakorede ST et al.[6]found a round shape of the pinna in Hausa ethnicity and an oval in Yoruba and Igbo which are in contrast to our study.

In our study, the Darwin's tubercle shows nodosity as the most common type in both males and females with no sexual dimorphism. In studies by Krishan K et al.[7]and Rani D et al.[8], the nodosity type of Darwin's tubercle was the most common in both males and females, which may be favourably compared with the findings of our study. According to a study by Ozioko O et al.[9], Darwin's tubercle was absent in Yoruba (87%) and Igbo (90%) ethnic groups.

In a study by Makaju S et al.[10], the most common type of tragus in females was round in both Indian and Nepali populations. Similar findings were observed in both sexes in a study by Swati M et al.[11]In the Meitei population, long-type tragus of the external ear was common in males, while it was round in females. Overall, for Meitei participants, the round type was the most common. However, the knob shape of the tragus was the most common type in both sexes on both sides in a study by Fakorede ST et al.[6]and Krishan K et al.[7] and in Hausa, Igbo and Yoruba tribes of Nigeria.

In the present study, the most common type of anti-tragus is medium, and it was prevalent in half of the ethnic Meitei study population. However, no sexual dimorphism could be ruled out. In a study by Kearney B[12], the most common type was round, with 80% in males and 68.6% in females. Gaya AA and Yahaya AI[13] found the flat type of anti-tragus to be the most common, with 68% in males and 57.4% in females.

The most common type of the shape of the lobule of the pinna was arched in both sexes in the present study. Rubio O et al.[14] observed that the most common type of lobule was the arched type in both sexes, which is similar to the findings of our study. Fakorede ST et al.[6] found the most common earlobe shape in Hausa ethnicity to be square and arched in Yoruba and Igbo. Triangular-shaped lobules were observed in 7.33% of males and 1.33% of females and the most common form in females was square and tongue in males in a study by Sezgin N et al.[15]

Lobule attachment to the cheek in the present study was found to be maximum, with the partially attached form in both the males and females with no sexual dimorphism. Meitei ethnicity showed that almost half of the study population had a partially attached lobule attachment to the cheek, with 44.30%. Similar findings were noted in a study by Rani D et al.[8], with partially attached earlobes as the most common in males (38.03%) and females (47.83%).

In our study of external ear morphology in ethnic Meiteis, the most common concha type is a proportionate type of concha in both sexes. No sexual dimorphism could be ruled out. However, the ethnic Meitei population shows a very high percentage of proportionate form of concha with 74.10%. According to a study by Gaya AA et al.[13], the shape of concha consisted of 13% narrow, 51% proportionate, and 36% broad in males, while 21.2% narrow, 59.6% proportionate, and 19.2% broad in females which is in agreement with the findings of our study.

In this study, the helical fold shape is maximum, with typically rolled helix in males and wide covering scapha in females. The Meitei study population showed an almost equal percentage of typically rolled and wide-covering scapha. A rolled helix was found in both sexes in a study by Singh P et al.[4], Krishan K et al.[7], and in another study by Swati M et al.[11]. However, in a study by Fakorede ST et al.[6], the most common form of the helix was found to be wide in all ethnicities of Hausa, Yoruba, and Igbo.

Conclusion

It may be concluded from the study's findings that no significant sexual dimorphism could be noted in the characters of the external ear in the Meitei

subjects except for the helical fold. A normally rolled helical fold in males and wide covering scapha in females were observed. As regards the uniqueness of the characters in ethnic Meiteis, it could be opined that the majority of the population manifested with the nodosity type of Darwin's tubercle, medium type of anti-tragus, and proportionate form of concha. Hence, a combination of external morphological characteristics observed in the study population may help determine the uniqueness of the pinna of the ethnic Meitei population and the establishment of its identity.

Ethical Clearance details: No.A/206/REB-Comm(SP)RIMS/2015/943/281/2022 from Research Ethics Board RIMS. Regional Institute of Medical sciences, Imphal, Manipur

Conflict of interest: Nil

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