



Study of Morphological Variations of External Ears in the College Students of District Panipat, Haryana

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<p>CC License CC-BY-NC-SA 4.0</p>	<p style="text-align: center;">Abstract</p> <p>The present study is aimed at describing different morphological features of the external ear, helix, tragus, types of Darwin's tubercles, shape, and forms of the earlobes. The study was conducted in the selected age group of college students of District Panipat of Haryana (India). The data of 125 students were collected which consists of 85 females and 40 males ranging in young age from 18 to 24 years. The occurrence and frequencies with respect to these features have been calculated graphically and population-based characteristics have been compiled to link these characteristics with a student's community.</p> <p>Key words: <i>External ear, college students, Panipat etc.</i></p>
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INTRODUCTION:

The human ear comprises the external ear, the middle and inner ear. The external ear is involved in the reception, selectivity, and direction of sound waves for hearing (Khamiss A. et al.) It is a useful but underutilized organ of the human body with regards to its potential for personal identification (Krishan K. et al.). Its shape and symmetry contribute enormously to facial beauty and aesthetics (Niemitz C. et al.). Additionally, the morphological studies of the external ear convey the information about age, sex and ethnicity which can be explored for personal identification, biometrics, and forensic purposes (Krishan K. et al. and Iannarelli 1989 et. al.). Like Fingerprints, footprints, facial morphological characters, iris, pattern of walk, teeth arrangement, bite marks, lip shape, nose shape, voice recognition characteristics, and DNA finger printing from a variety of tissues of the human body have successfully been utilized in personal identification and in forensic situations as well as for identification of criminals. The human ear is one of the most important sensory organs of the body which is unique of every individual. Like fingerprints and other characteristics of the human body, the ear retains certain individualistic characteristics which are unique due to variations in the anatomical structure of the external ear (Iannarelli 1989). The earprints can be left by the criminals/burglars while listening at the doors or windows of the target house. In the present scenario when the crimes are recorded by CCTV cameras, an expert may be asked to identify the individual/suspect based on CCTV footage where the ear of the suspect is clearly visible.

Many studies have been conducted worldwide to show variations in human ears morphologically. Some recent studies (Vanezis et. al. 1996; Cameriere et al. 2011; Purkait 2016; Verma et. al. 2016; Rubio et. al.

2017) have shown that every part of the external ear is morphologically unique and shows reasonable variations in individuals and population groups.

The present studies have described different shapes of the ear, helix, tragus, types of Darwin's tubercles, shape, and forms of the earlobes. The occurrence and frequencies with respect to these characteristics have been calculated graphically and population-based characteristics have been compiled to link these characteristics with a student's community.

Materials and methods

The study was conducted in the selected age group of college students of District Panipat, Haryana (India). The data of 125 students were collected which consists of 85 females and 40 males ranging in young age from 18 to 24 years. The legal and ethical consent of the students was taken before getting the data collection. Participation in the study was voluntary and a verbal informed consent was sought.

Methodology

Morphological characteristics of the study were evaluated to develop standards for the unique morphology of the ear in the student's population. The ears of the subjects were photographed, and some peculiar characteristics were noted in the studied population. The photographs of the ears were taken with the help of Nikon D 5200 camera with 18-55 lenses sat the same distance in all the subjects.

Morphological characteristics of the Human Ear

The human ear can be considered as unique due its exclusive morphological structure and the organization of its various parts (Fig. 1). Overall shape of the ear; size and shape of the tragus; shape of earlobe; shape of the helix; forms of Darwin's tubercle etc. were studied in both ears. The following anthropological characteristics were observed in the ears of the subjects followed by a study conducted by Singh and Purkait (2007).

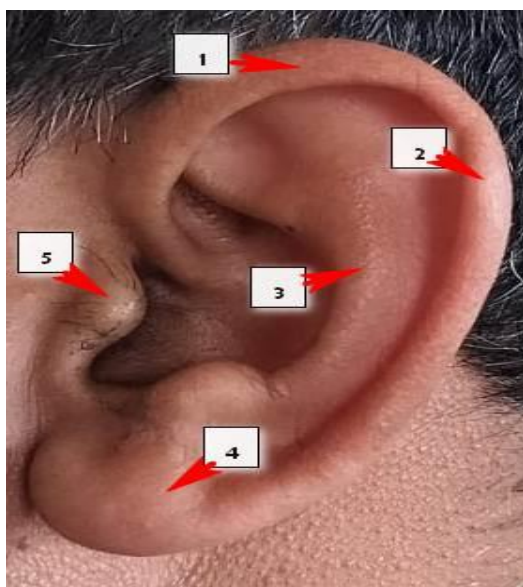


Figure1. Shape of the ear

Figure1. Shape of the ear: Oval, oblique, rectangular, round, and triangular. 1-Shape of the helix: concave marginal, normally rolled, flat and wise covering scapha. 2-Darwin's tubercle: Nodosity, Enlargement and Projection. 3-Crural of antihelix. 4- Shape of the earlobe: Arched, tongue, square and triangular. 5-Shape of the tragus: Double knob, single knob, and round. The frequency distribution of these traits was evaluated separately in males and females in both the left and right ears, and simple frequency tables and graph were made for interpretation of the results.

RESULTS:

The results of the present study show that both ear is unique in shape and size even both ears of the same individual. The unique characters of the ear can be studies with the help of variations in the ear morphology of every individual.

1. Shapes of the Ear.

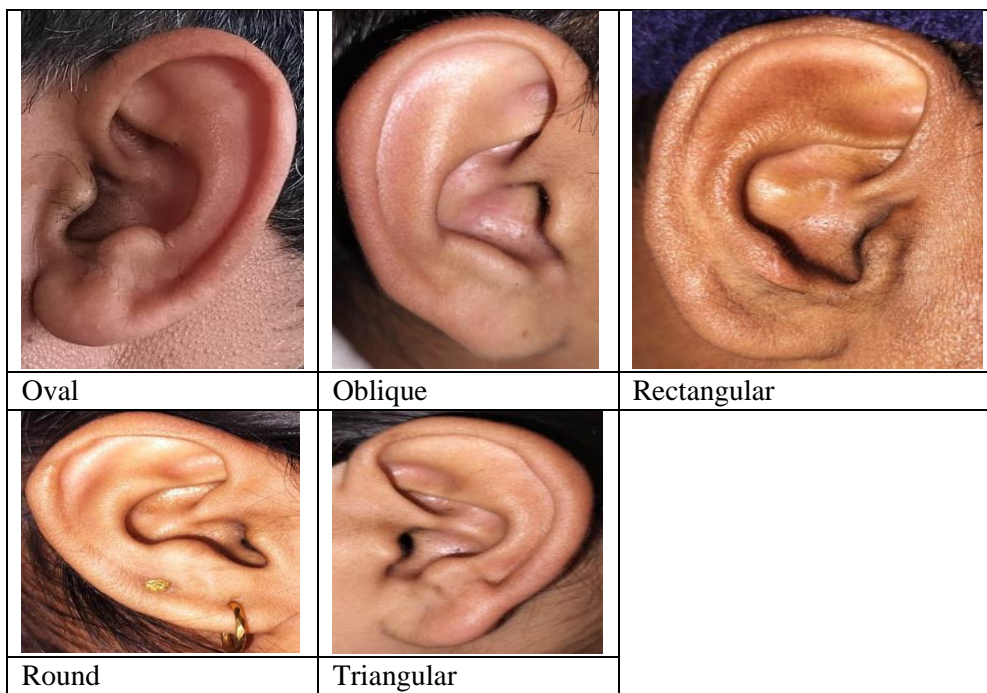
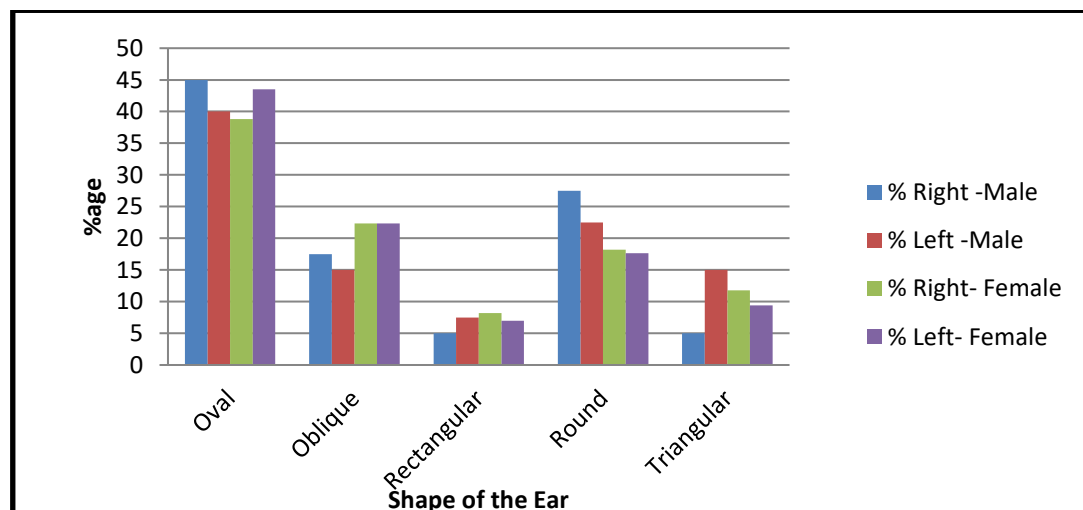


Figure-2 Shapes of the Ear.

Table1. Shapes of the Ear (N = 40males and N= 85females)

Shape of the Ear	Male				Female			
	Right		Left		Right		Left	
	N.	%	N.	%	N.	%	N.	%
Oval	18	45	16	40	33	38.82	37	43.52
Oblique	7	17.5	6	15	19	22.35	19	22.35
Rectangular	2	5	3	7.5	7	8.2	6	7
Round	11	27.5	9	22.5	16	18.2	15	17.64
Triangular	2	5	6	15	10	11.76	8	9.41
Total	40	100	40	100	85	100	85	100



Graph-1of table-1.

Table 1 shows the frequency of the overall shape of the left and right ears in both sexes. The results shown in the graph Oval shape of the ear was common (R- 45% and L- 40 % in males while in females R-38.82% and L-43.52%) among the overall sample of the study in both sexes. The round shape of the ear was (R- 27.5% and L- 22.5 % in males while in females R-18.02% and L- 17.64%) and oblique shape (R- 17.5% and L- 15 % in males while in females R-22.35% and L- 22.35%) of the ears were the variants reported in the study. The other types of the ear such as the rectangular and triangular were also found in both sexes. Slight sex differences were observed as regards the overall shape of the ears in the subjects. Bilateral asymmetry exists as regards the shape of the ear, however, not significant.

2. Shapes of the Ear-helix.

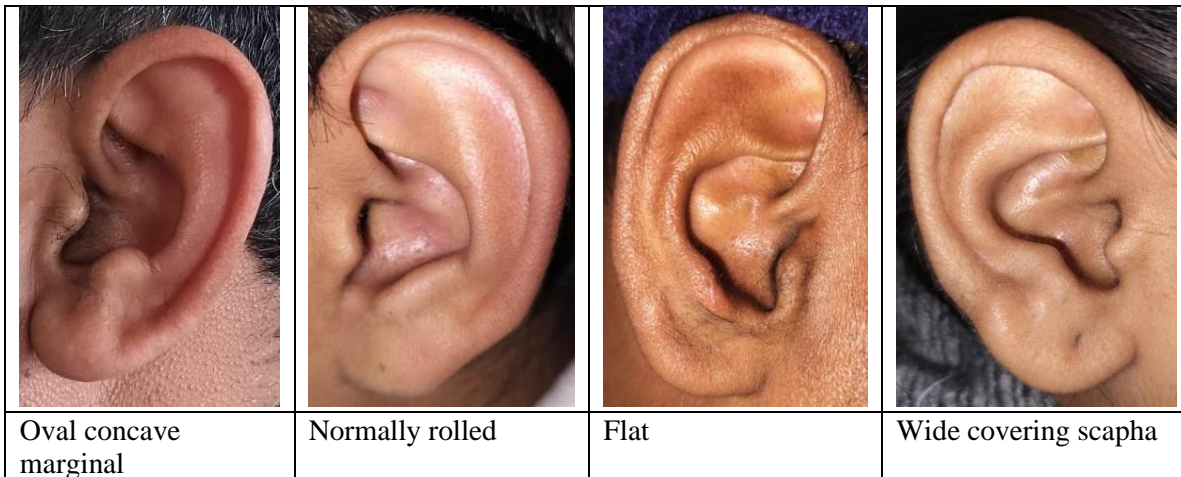
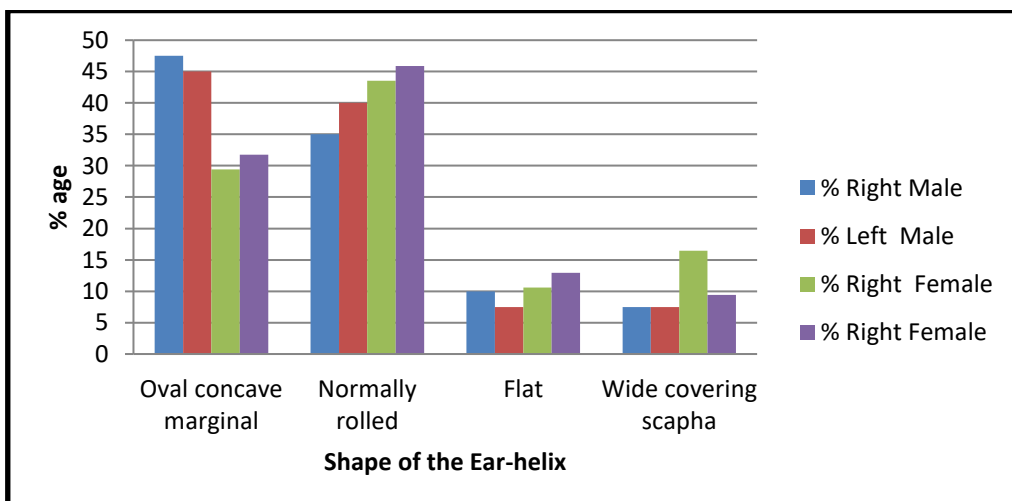


Figure-3 Shapes of the Ear-helix.

Table 2 Shapes of the Ear- helix in males (N = 40) and females (N = 85)

Shape of the Ear-helix	Male				Female			
	Right		Left		Right		Left	
	N.	%	N.	%	N.	%	N.	%
Oval concave marginal	19	47.5	18	45	25	29.41	27	31.76
Normally rolled	14	35	16	40	37	43.52	39	45.88
Flat	4	10	3	7.5	9	10.58	11	12.94
Wide covering scapha	3	7.5	3	7.5	14	16.47	8	9.4
Total	40	100	40	100	85	100	85	100



Graph-2 of table-2

In this graph, details the frequency distribution of the shape of the helix (Fig. 3) shows that the helix is highly variable in the individuals showing certain characteristics such as normally rolled helix, concave, flat, and wide covering scapha helix. Normally rolled helix was common (R-43.52 and L- 48.3% in females while in males the oval concave marginal was R-47.5% males and L-45%) among both sexes in the studied population. The other types of the helix such as flat and wide covering scapha helix were present.

3. Shapes of the Earlobe

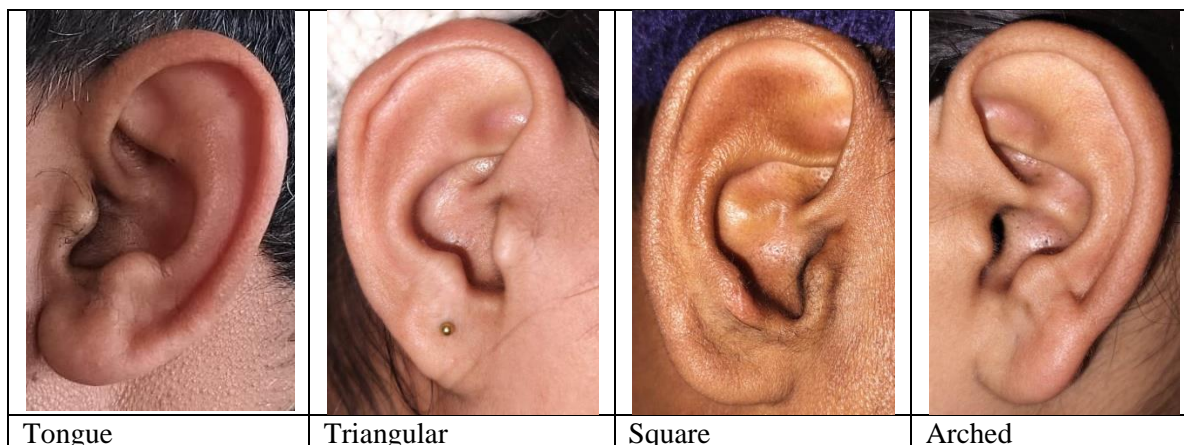
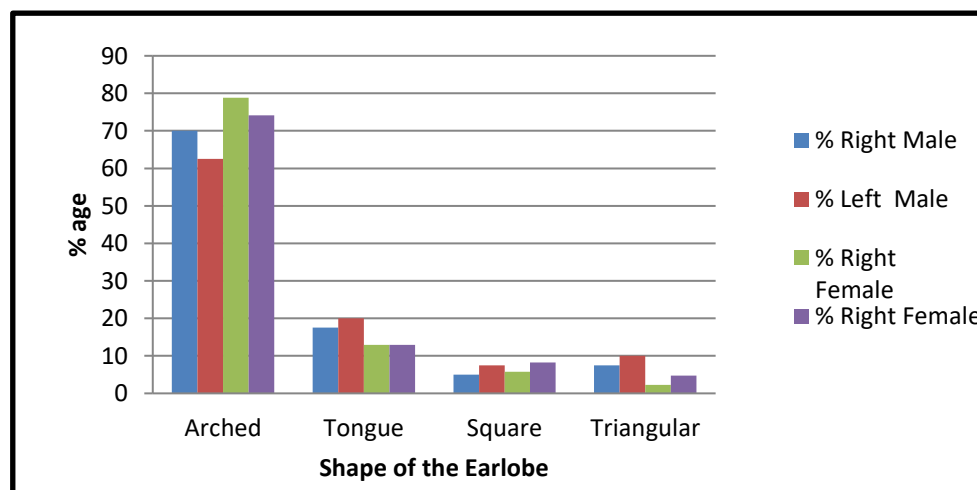


Figure 4 Shapes of the Earlobe

Table3. Shapes of the Earlobe (N = 40males and N= 85females)

Shape of the Earlobe	Male				Female			
	Right		Left		Right		Left	
	N.	%	N.	%	N.	%	N.	%
Arched	28	70	25	62.5	67	78.82	63	74.11
Tongue	7	17.5	8	20	11	12.94	11	12.94
Square	2	5	3	7.5	5	5.8	7	8.2
Triangular	3	7.5	4	10	2	2.3	4	4.7
Total	40	100	40	100	85	100	85	100



Graph-3 of table-3.

This table 3 shows the frequency distribution of the shape of the left and right earlobe (Fig. 3) among the studied sample. The shape of the earlobe is different types such as arched, tongue shaped, square, and triangular. Arched earlobe was found to be common (R- 70% and L- 62.5% in males while in females the percentage was R- 78.82% males and L-70.11%) among both sexes in the studied population. The square type and triangular types of the earlobes were the rare variants reported in the study.

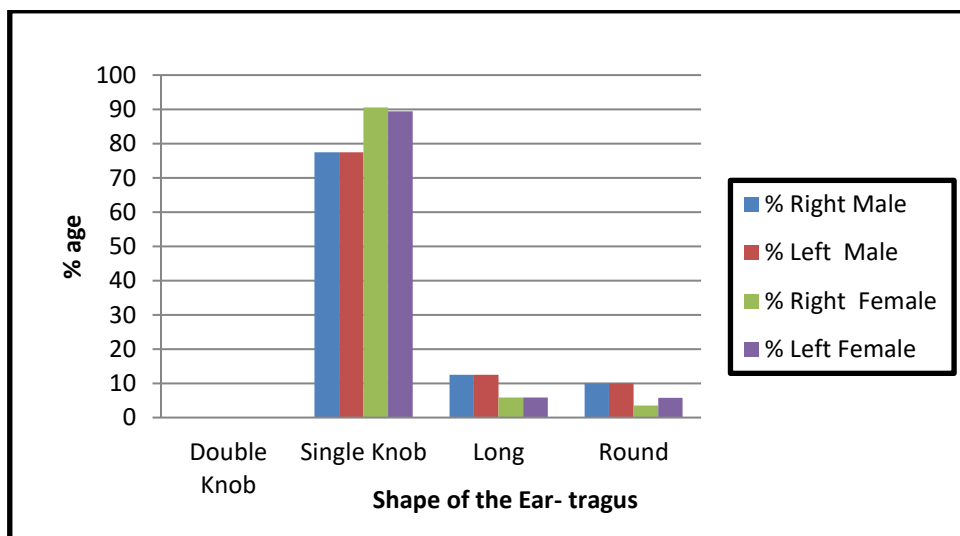
4. Shape of the Ear-tragus



Figure-5 Shape of the Ear-tragus.

Table4. Shape of the Ear-tragus (N = 40males and N= 85females)

Shape of the Ear-tragus	Male				Female			
	Right		Left		Right		Left	
	N.	%	N.	%	N.	%	N.	%
Double Knob	0	0	0	0	0	0	0	0
Single Knob	31	77.5	31	77.5	77	90.58	76	89.41
Long	5	12.5	5	12.5	5	5.88	5	5.88
Round	4	10	4	10	3	3.5	5	5.8
Total	40	100	40	100	85	100	85	100



In this, table 4 shows the frequency distribution of the shape of the tragus (Fig. 4) among both sexes in the studied subjects. Single knob tragus was found to be in males while in females the percentage was found R-90.58%males and L-89.41%) among both sexes in the studied population. The results indicate that the significant sex differences exist as far as the single knob tragus is concerned with predominance in females. The frequency of the double knob tragus was not found in both sexes. The variable frequency of Long-type tragus and Round-type tragus was observed in the left and right sides, respectively, in both sexes. The shape of the tragus also varies with respect to the left and right sides as well as sexes.

5. Shapes of the Darwin's tubercle

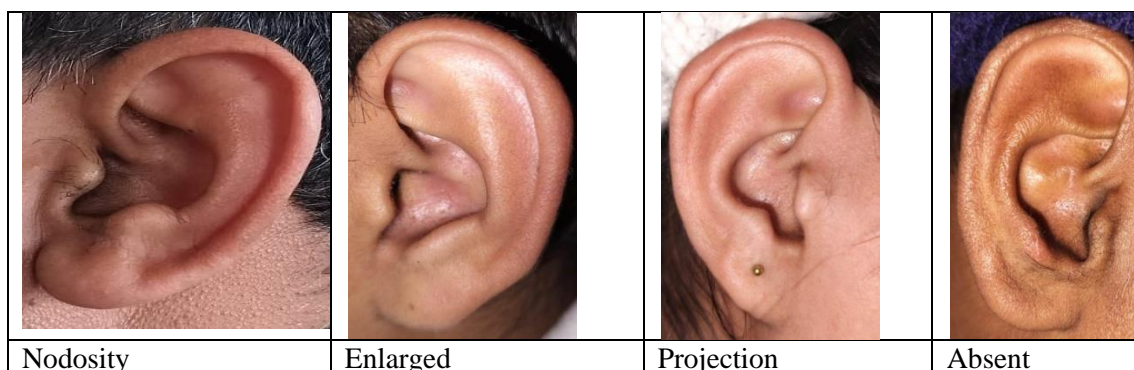
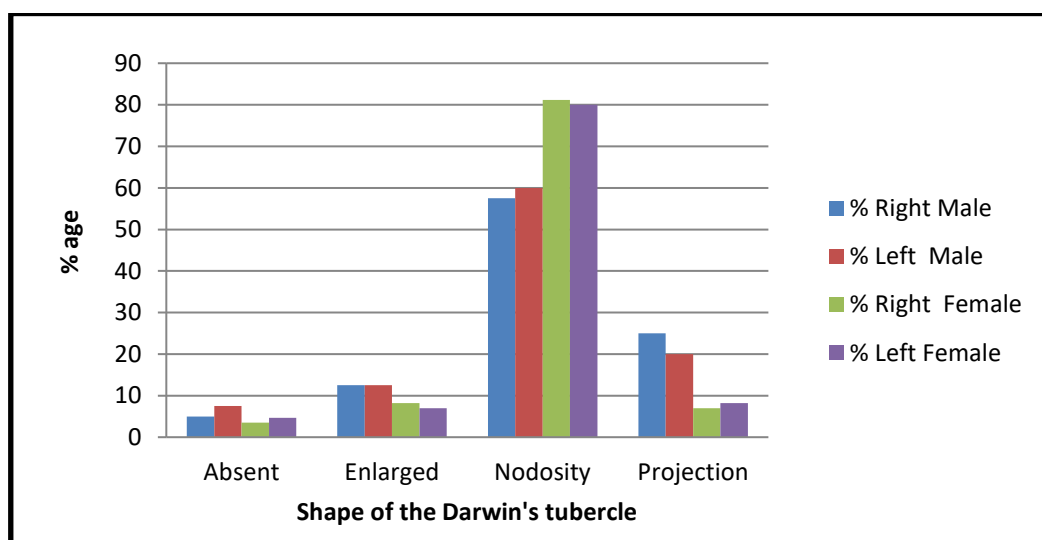


Figure 5 Shapes of the Darwin's tubercle

Table 5. Shapes of the Darwin's tubercle (N = 40 males and N= 85 females)

Darwin's tubercle	Male				Female			
	Right		Left		Right		Left	
	N.	%	N.	%	N.	%	N.	%
Absent	2	5	3	7.5	3	3.5	4	4.7
Enlarged	5	12.5	5	12.5	7	8.2	6	7.0
Nodosity	23	57.5	24	60	69	81.17	68	80
Projection	10	25	8	20	6	7.0	7	8.2
Total	40	100	40	100	85	100	85	100



The table 5 shows the frequency distribution of the various shapes of the Darwin tubercles present on the left and right ears of the subjects. Darwin's tubercle refers to a congenital prominence usually found on the posterior part of the helix of the ear (Loh and Cohen 2016). In the present study, it shows a variety of structures in both the left and right sides in both sexes. The trait is usually found on the posterior aspect of the helix; however, in some cases, it was also found on the superior aspect in the present study (Fig. 5). Nodosity-type Darwin's tubercle was found to be common (R- 57.5% and L- 60% in males while in females the ratio was R-81.17% and L- 80% females) among both sexes. Enlargement and projection form of the Darwin's tubercle was among the rest of the subject, and in few subjects, the Darwin tubercle was totally absent.

DISCUSSION:

The present study is done on five types of ear variations exhibited by both external ears i.e. shape of the ear, curve of helix, tragus, ear lobe shape, Darwin's tubercle etc. A few studies are available in the literature (Rubio et al. 2017; Cameriere et al. 2011; Purkait 2016; Verma et al. 2016; Vanezis et al. 1996; Purkait and Singh 2008; Alexander et al. 2011; Kearney 2003) regarding the morphological characteristics of the ear

which enhance the anthropological and forensic knowledge about the ear and its variability in different populations. The results of the morphological features of the ear in the present study can be compared with a few similar studies conducted worldwide. According to (Van der Lugt et al.), oval shaped ears in Dutch males were 68.7%. Iannarelli demonstrated that 65% of Americans possessed oval shaped ears. The present study illustrates that the commonest shape of external ear is oval, (R- 45% and L- 40 % in males while in females R-38.82% and L- 43.52%). The decreasing order of frequency of other shapes was triangular, round, and rectangular. The values were compared with other studies (Van Der Lugt C et al., Chattopadhyay PK et al.). When the shape of ear helix was studied, four types of patterns were observed i.e., normal rolled, wide covering scapha, flat helix and oval marginal concavity of the helix. However, Farkas (1978) found 76–79% of normally rolled helix in Americans, while (Singh and Purkait,2009) observed 56–60% normally rolled helix in Central Indian subjects. The concave marginal type was found among about 28–48% in the present study; however, Singh and Purkait (2009) observed this character among 10–11% of their subjects and North Americans also possess this character rarely (25%). The frequency of wide covering scapha was found to be very low in North American males (5.20%) (Farkas 1978) and Central Indians (6.42%) (Singh and Purkait 2009) and comparable to about 4.4% as observed in the present study. In the present study, Normally rolled helix was common (R-43.52 and L- 48.3% in females while in males the oval concave marginal was R-47.5% males and L- 45%) which corresponded to the values from the study done by (Krishnan et al.). The decreasing order of occurrence in males was concave marginal helix, flat helix and wide covering scapha in that order. But females possessed normally rolled helix in more numbers as compared to oval concave marginal. On the other hand, in the females of the present study, the frequency of the character was 43% - 48% %, much higher than those of Central Indians (3.28%) and Americans (5.15%). The earlobe also shows a variety of characteristics in different populations. The shape of the earlobe is different types such as arched, tongue shaped, square, and triangular. In this study Arched earlobe was found to be common (R- 70% and L- 62.5% in males while in females the percentage was R- 78.82% males and L-70.11%) among both sexes in the studied population. In case of ear tragus, the single knob tragus was found to be in males while in females the percentage was found R- 90.58% males and L- 89.41%) among both sexes in the studied population. The present study shows significant sex differences exist as far as the single knob tragus is concerned with predominance in females. The frequency of the double knob tragus was not found in both sexes. The variable frequency of Long-type tragus and Round-type tragus was observed in the left and right sides, respectively, in both sexes.

Darwin's tubercle is an important structure of the ear which is considered to have some evolutionary significance (Loh and Cohen 2016). It can be described in various categories such as nodosity, enlargement, and projection. Bertillon (1893) described four conditions of Darwin's tubercle, i.e., nodosity, enlargement, projection, and tubercle. In the present study, the Darwin's tubercle was not only found on the posterior part of the helix but on the superior helix also. In Central Indian population (Singh and Purkait 2009), the frequency of nodosity was the highest, i.e., 54–62%, which can well be comparable to the present study, i.e. 46–67.8%. In the present study nodosity-type Darwin's tubercle was found to be common (R- 57.5% and L- 60% in males while in females the ratio was R-81.17% and L- 80% females) among both sexes. Enlargement and projection form of the Darwin's tubercle was among the rest of the subject, and in few subjects, the Darwin tubercle was totally absent.

A variety of the structures of these morphological features of the ear may be helpful in personal identification in forensic examinations. However, these features are not sufficient to establish the personal identity (Yuan and Chun Mu 2012; Kumar and Wu 2012; Kumar and Chan 2013). However, the modern system of identification using new computerized techniques such as automatic identity recognition and local information fusion by ear images is based upon some computerized algorithms; however, they must be compensated with the knowledge-based morphological variations. The present study was done on the student's population of District Panipat. It can be extended further to be done on population from other parts of the state.

CONCLUSION:

The study concludes that the oval-shaped ear was common in the study sample. The studied population also showed other types of the ear such as oblique, rectangular, round, and triangular in both sexes. The shape of the tragus also varied with respect to the left and right sides as well as sexes. The earlobe showed different characteristics in different individuals. As regards the uniqueness of the ear, the study confirms that every human ear is unique and consequently its impression also because of the sufficient variability encountered in the external structure of the ear. The study provides new information on the ear variability and characteristics

of a north Indian population which will add to the anthropological knowledge and morphological variability of the ear structure for further use.

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