Morphometric study of human auricle in the age group of 18-24 years in North West part of India

L Arora1*, V Singh2

ABSTRACT
Introduction With the latest invention in tissue engineering of cartilage, the reconstructive surgeries of human auricle can be a better option for getting tissue for 3D structures which cause minimal donor site morbidity. But dimensions of auricle vary in various races and age groups. Therefore we have confined our study in northwest part of India and in age group of 18-24 years.

Material and Methods Different parameter of auricle that is length and width of auricle, lobular length and width, conchal length and width were measured with the help of vernier callipers. Protrusion of ear at superaurale and tragal level were measured with the help of geometric set of squares.

Result The result showed mean values of length of auricle, width of auricle, lobular length, lobular width, conchal length, conchal width, protrusion at superaurale level and protrusion at tragal level respectively as 61.57±3.55, 31.04±2.69, 18.3±1.97, 18.77±2.13, 27.75±2.09, 19.83±2.24, 16.5±0.25, 25.7±0.25 for the right ear and 61.61±3.41, 31.41±2.97, 17.82±2.23, 18.68±2.16, 28.16±2.24, 20.01±2.64, 1.75±0.25, 2.55±0.25 for the left ear in males. However the values in females were respectively, 56.74±3.75, 29.40±2.50, 17±1.96, 16.03±2.78, 24.88±3.13, 17.20±1.90, 15.5±0.27, 22.3±0.34 for the right ear and 56.48±3.65, 29.40±2.52, 17.03±1.88, 16.06±2.78, 24.91±3.01, 17.28±1.96, 1.56±0.25, 2.17±0.35 for the left ear.

Conclusion Thus our study aims to find the mean values of different morphometric measurements of right and left ear in the present study population.

Keywords: morphometry, human auricle

INTRODUCTION
The auricle has a significant role in the diagnosis of congenital deformities. Any deformation in shape, size and spatial position of auricle can help in diagnosis of anomaly. Therefore knowledge of normal ear dimensions and ear growth pattern helps in diagnosis of various congenital anomalies. The auricle develops from series of elevations at dorsal end of first pharyngeal arch called ‘auricular hillocks’. Three elevations appear around each side of external meatus which are seen at 6 weeks of gestational period. These hillocks are transitory and later fuse to form definitive auricle1. As fusion of auricular hillock is complicated, developmental anomalies of auricle are common. Initially auricles are ventrolaterally placed in lower neck region, but at end of embryonic period they assume dorsolateral position and ascend to side of neck at level of eyes. Malformations of the ear may be related to size of auricle, shape of ear and position of ear. Marfan’s syndrome and Fragile X syndrome, for example are reported to have macrotia that is large ears. Trisomy 13-15 and anencephaly cases have dysplastic ears. Mean ear length and measured expected ear length ratios are significantly lower in 75% of foetuses with trisomy
Several studies have been reported on auricle involving various syndromes and anomalies. The relevance of these studies is to identify optimal age for surgical correction of congenital malformed ears. The human ear is a defining feature of face. Any defect in disproportionate size of auricle or its missing part can be corrected by cosmetic surgery. Researchers have demonstrated that with currently available techniques, biomaterial and biomolecules the neocartilage can be constituted in predetermined stage and complex 3D structure of ear can be regenerated which will help in tissue reconstructive surgeries. For these surgeries cosmetic surgeon needs data about normal auricle dimension, auricle's bilateral position and general conformation. But these data varies in different races. Studies have been conducted in different population of world. Bozkir MG et al. studied human auricle in Turkish population and Azaria R et al. studied the Jewish population. Brucker MJ et al. studied the age and sex related changes in human auricle in American population. India is a multiracial country and measurements in population of one region may not match with that of other region. Sharma A et al. studied the morphometry of ear lobe in males of northwest region of India and Purkait R et al. investigated the male population in central India. Only few studies have been reported from India and data available is frugal. Thus we have attempted to provide anthropometric data of normal adult male and female auricles from north west part of India.

The studies of the ear are important for surgical techniques for the treatment of congenital deformities and reconstruction of traumatically injured ears. Lobular parameters are important for plastic surgeons who aim to achieve proper balance between right and left ear lobes in reconstruction surgeries. These parameters also give information on age and sex and play valuable role in forensic investigations.

Metric analysis requires the choice of an appropriate standard because there is evidence that populations are metrically distinct. Brucker et al. studied the ear morphometry in age from 20-80 years. According to Brucker et al. significant age changes were observed only in the length of lobule, while width of lobule decreased reciprocally. Sforza C et al. studied age and sex related changes in Italian population and Barut et al. measured the auricle of Turkish population. On reviewing literature we found that very few auricular studies have been reported from India. Frugal data on the auricle have been presented by Lakshmiarayana et al. in their report on the facial growth of South Indian. Hence current study was attempted to provide anthropometric data on normal adult male and female auricles from north west part of India.

MATERIALS AND METHODS
Linear measurement of human auricle was taken with the help of vernier callipers of 50 undergraduate students both male and female. The student sat upright with his/her head in Frankfurt horizontal plane. Measurements were taken following Purkait R 2007 method. Students signed on the consent form; the copy of consent form is attached with the paper. Following parameters were measured (see figures page 3):

1. Length of auricle (ab) (fig. 1)
2. Width of auricle (cd) (fig. 1)
3. Lobular length (ij) (fig. 2)
4. Lobular width (kl) (fig. 2)
5. Conchal length (ef) (fig. 2)
6. Conchal width (gh) (fig. 2)
7. Protrusion at superaurale level
8. Protrusion at tragal level

For readings of auricular protrusion at superaurale and tragal level a geometric set square was used with its base resting on mastoid area. From these measurements mean and standard deviation were calculated for each parameter. Statistical analysis using t-test was undertaken to study the bilateral variation.

RESULTS
Readings of different measurements of both ears of 50 males and females is shown in Table 1 and Table 2 (see page 4)
Figure 1 Landmarks of auricle for measuring length and width of auricle

Figure 2 Landmarks of auricle for measuring length and width of concha, and length and width of lobule
Table 1 Different auricular dimensions in male students, n=50

<table>
<thead>
<tr>
<th>Measurements (mm)</th>
<th>Right Ear</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Left Ear</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Correlation between readings of right and left side</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of auricle</td>
<td>61.57</td>
<td>3.55</td>
<td>61.61</td>
<td>3.41</td>
<td>.921</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of auricle</td>
<td>31.04</td>
<td>2.69</td>
<td>31.41</td>
<td>2.97</td>
<td>.931</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobular length</td>
<td>18.3</td>
<td>1.97</td>
<td>17.82</td>
<td>2.23</td>
<td>.937</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobular width</td>
<td>18.77</td>
<td>2.13</td>
<td>18.68</td>
<td>2.16</td>
<td>.891</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conchal length</td>
<td>27.75</td>
<td>2.09</td>
<td>28.16</td>
<td>2.24</td>
<td>.878</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conchal width</td>
<td>19.83</td>
<td>2.24</td>
<td>20.01</td>
<td>2.64</td>
<td>.909</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protrusion at superaurale level</td>
<td>16.5</td>
<td>.25</td>
<td>1.75</td>
<td>.25</td>
<td>.862</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protrusion at tragal level</td>
<td>25.7</td>
<td>.27</td>
<td>2.55</td>
<td>.25</td>
<td>.795</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Different auricular dimensions in female students, n=50

<table>
<thead>
<tr>
<th>Measurements (mm)</th>
<th>Right Ear</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Left Ear</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Correlation between readings of right and left side</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of auricle</td>
<td>56.74</td>
<td>3.75</td>
<td>56.48</td>
<td>3.65</td>
<td>.932</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of auricle</td>
<td>29.40</td>
<td>2.50</td>
<td>29.40</td>
<td>2.52</td>
<td>.993</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobular length</td>
<td>17.00</td>
<td>1.96</td>
<td>17.03</td>
<td>1.88</td>
<td>.971</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobular width</td>
<td>16.03</td>
<td>2.78</td>
<td>16.06</td>
<td>2.78</td>
<td>.996</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conchal length</td>
<td>24.88</td>
<td>3.13</td>
<td>24.91</td>
<td>3.01</td>
<td>.997</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conchal width</td>
<td>17.20</td>
<td>1.90</td>
<td>17.28</td>
<td>1.96</td>
<td>.979</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protrusion at superaurale level</td>
<td>15.5</td>
<td>.27</td>
<td>1.56</td>
<td>.25</td>
<td>.858</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protrusion at tragal level</td>
<td>22.3</td>
<td>.34</td>
<td>2.17</td>
<td>.35</td>
<td>.937</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistical analysis showed no significant difference between the readings of left and right side and a positive correlation between the readings of right and left side. The parameter most useful for mass survey is auricular length and width.16

DISCUSSION AND CONCLUSION
The most prominent feature of face is ear which makes human face aesthetically and naturally appealing. For many years reconstructive surgeries of auricles were challenging to the surgeons. But tissue engineering of cartilage for reconstructive surgeries has proven to be a promising option14. Therefore the study of exact morphometry of human ear has become all the more important. The dimensions are different in various ethnic groups which are necessary for the surgeon to work on the data specific to ethnic group.

The size of human auricle increases with age even after it’s complete development12. The increase is attributed to elastic fibres in auricular cartilage. A significance of age was found with larger values in older individuals. Therefore our study is to provide
data in males and females in age group of 18-24 years from north west part of India.

Total height of ear is important in diagnosis of congenital anomalies. In North American whites total height of ear auricle has been reported to be 62.4 mm in males and 58.5 mm in females (Asai Y 1990) and in Japanese population the ear height is 70.1 mm. Bozkir et al. reported the height of ear auricle in Turkish population to be 62.9 mm in females and 63.1 mm in males. Our results are more similar to North American and Turkish population than with Japanese population.

Due to recent development in tissue reconstructive surgeries, we have reported the width of auricle. Width of the auricle has not been reported by many authors except Bozkir et al. in Turkish population which is quite similar to our study.

The dimensions of ear lobe reported in different studies varies from 13 mm to 25 mm. But in our study length and width of ear lobe was found to be around 18 mm in males and 17 mm females.

The conchal length and width has not been extensively reported in literature except for in Central India population. They reported conchal length to be around 26 mm and width around 18 mm which was quite similar to our study.

The knowledge of measurement of auricular protrusion is useful in designing of hearing aid instrument. The hearing aid is either fitted behind the ear or surgically anchored to mastoid. As cited by Pukrait R et al. in Indians protrusion of auricle at superaurale level is around 10.5 mm to 16.1 mm and at tragal level ranges between 18.8 mm to 24.8 mm. Our readings almost fall in this range.

In our measurements no difference was found between the readings of right and left side but difference between paired structures of right and left parts of human face has been reported by other authors.

Thus we conducted this study to generate interest and further research on the knowledge of ear dimensions, especially in the north west part of India, where data is limited. The data provided will help in diagnosing of congenital and acquired deformity and will also provide guidelines to plastic surgeons to correct deformity. Moreover the data provided will help in recent developments of medicines, such as, tissue engineering of ear cartilage for reconstructive surgeries.

REFERENCES
1. T W Sadler Langman’s Medical Embryology in Ear.10 edition Lippincott Williams and Wilkins 2006, pp 322


