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Computed tomography measurement of the auricle in Han population of north China

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Summary A large number of anthropometric studies of the human auricle have been conducted in various populations. However, data from Han Chinese population are currently not available. The morphology of the auricle is highly complex. Consequently, traditional direct measurement techniques are unable to provide sufficient detail and accuracy. The present study sought to provide anthropometrical data on the auricles of Han Chinese individuals using a three-dimensional (3D) computed tomography (CT) reconstruction technique. A total of 485 data sets were utilised for this study. This sample consisted of data from 241 females aged 18—75 years and 244 males aged 18—74 years. All participants were categorised by gender and further into three age groups. Twelve anthropometrical dimensions of normal auricles were measured with 3D CT. Auricular, tragal, lobular and conchal indices were calculated to further examine the auricles. Earlobes were classified into three basic groups according to the angle of the junction of the earlobe with the cheek. Few of the anthropometrical data showed significant bilateral differences in auricular dimensions. The height of the tragus, lobular length, lobular width, conchal width, protrusion at tragal level and inclination angle of auricles showed no significant differences between males and females. All the linear dimensions of auricles, except the height of the tragus, conchal length and width, increased with age for both males and females. Protrusion at the superaurale and tragal levels showed a decrease of between 4% and 9% for males and 4% and 10% for females across all age groups. This study is the first to report CT measurement of normal auricles in a northern Han Chinese population. We found that this method enabled the complexity of the ear to be measured easily and accurately. Increasing our knowledge of normal auricular dimensions will be beneficial for plastic surgeons.

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The auricle is one of the five primary features of the human face and is particularly influential in determining its appearance.[1] Cosmetic surgery and auricular rejuvenation are becoming increasingly widespread. The morphology of the auricle is highly complex (Figure 1). Plastic surgeons thus require detailed information about typical auricular dimensions, the bilateral position of the auricles on the face and typical dimensions. Auricular dimensions, however, have been found to vary across different ethnic groups.[1] A large number of anthropometrical studies of the human auricle have been reported in different national groups. For example, Brucker et al. measured the auricle of American individuals and analysed age- and sex-related differences.[2] Gualdi-Russo[3] and Ferrario et al.[4] conducted a similar study in an Italian population. In addition, Purkait and Singh investigated the auricle of adult Indian men.[1] Azaria et al.[5] surveyed the earlobes of an Israeli population while Bozkir et al.,[6] Kalcioglu et al.[7,8] and Barut[9] examined the auricles of Turkish people. However, at present there are no equivalent data for a Han Chinese sample.

Many of the existing anthropometry data on the auricle have been gained using direct measurement techniques, used to assess the dimensions, location, inclination and level of a typical ear. However, there are many difficulties in using these traditional techniques for auricular measurement. Direct dimensional measurements are often prone to inaccuracy because of distortion of the soft tissues of the natural ear and difficulties in locating landmarks.[10]

In the last few years, three-dimensional (3D) reconstructive techniques have been applied to measure soft tissues. Several imaging-based methods for measuring living facial soft tissue thickness have been reported. These include lateral cephalometric radiography,[11] computed tomography (CT),[12] ultrasound[13] and magnetic resonance imaging (MRI).[14] CT is currently the most accurate imaging modality. After its emergence in the early 1970s, CT produced revolutionary diagnostic improvements in the medical field. Multiple axial views of the head and neck area provide information not only on bony hard tissue, but also on soft tissue of the facial area. A study by Kee-Deog et al.[15] affirmed the precision and accuracy of facial soft tissue measurement using personal computer-based multiplanar reconstructed CT images. Coward et al.[16] captured 3D data from a living human ear using CT, and concluded that the method was reliable. Using this method, the complex distortion of the natural ear can be measured easily, and the difficulty in locating landmarks may be overcome. The current study sought to provide anthropometrical data on normal auricles in a Han Chinese sample using a 3D CT reconstruction technique.

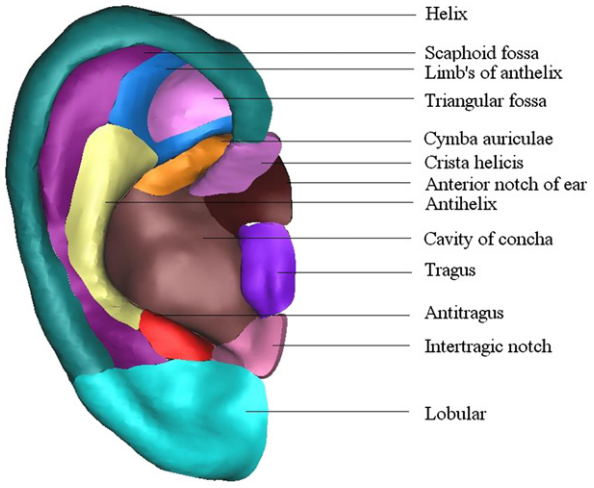

Figure 1 Anatomical names for each part of the auricle.

Materials and methods

We studied the CT data of 485 adult Han Chinese people (244 males and 241 females). The average ages of the subjects were 44.2 years (18—74 years) for males, and 46.3 years (18—75 years) for females. To examine the relationship between auricle dimensions and age, the data were divided into three age subgroups. The ranges of the three groups were as follows: group 1, between 18 and 40 years; group 2, between 41—60 years; and group 3, more than 60 years of age. The individuals were chosen based on their overall age dispersion within the data. These groups were determined following the methodology used by Azaria.[5] Each age group was made of at least 80 people. Any CT data displaying auricular abnormalities (congenital or acquired) or maxillofacial anomalies was excluded from the study. All the CT images used in this study were selected from the existing database in several hospitals which have the same helical CT imaging machine. All the subjects in the database had their own need for a CT scan such as craniofacial tumours, fractures and so on. This study has been reviewed by the institutional Ethics Committee and has followed their guidelines.

CT imaging was performed using a helical CT imaging machine (General Electric Company, Fairfield, USA). The protocol included images generated at 120 kV with a 225 mA X-ray. The slice thickness of the reconstructed images was 1.25 mm, and the image matrix size was 512×512. MIMICS 10.01 software (Materialise Co., Leuven, Belgium) was used to create the 3D CT images and measure the 3D reconstructed auricle. All measuring points were determined using 3D reconstructed images. Sixteen anthropometrical 'landmarks' on the auricles were used to record 12 dimensional measurements.

The measurements (shown in Figure 2) were as follows:

1. Length of the auricle (1—2).
2. Width of the auricle (3—4).
3. Insertion length of the auricle (5—6).
4. Length of tragus (7—8).
5. Height of tragus (9—10).
6. Lobular length (11—2).
7. Lobular width (12—13).
8. Conchal length (11—14).
9. Conchal width (15—16).
10. Protrusion at superaurale level (Figure 2b).
11. Protrusion at tragal level (Figure 2b).
12. Inclination angle of the auricle. (The angle between the axis of the auricle and the bridge of the nose; the line connecting landmarks 1 and 2 was taken as the axis of the auricle (Figure 2c).)

To further evaluate the variety of auricles in different age and sex groups, the length and width (height) of the