Comparative Assessment of Auricular Measurements in Young Males and Females

Evaluación Comparativa de las Medidas Auriculares en Hombres y Mujeres Jóvenes

Elif Esra Kent; Mehmet Emirzeoglu; Emrah Altunsoy; Mahmut Özel & Ahmet Uzun

SUMMARY: Personal identification is mostly done by facial assessment. The auricle plays a key role in the evaluation and recognition of the craniofacial complex. The aim of this study was to provide normative database using the measurements of the auricle among young males and females by anthropometric methods. Anthropometric measurements were taken from 115 participants, (56 men and 59 women) between 18-30 years old. Participants werestudents at Yasar Dogu Faculty of Sport Sciences of OndokuzMayis University. Each participant signed an informed consent form and then participated to the study. We found that the mean length of the right and left auricles were 58.30-58.52 mm, the mean width of the right and left auricles were 30.04-29.73 mm, the mean length of right and left lobules were 16.05-16.45 mm, and the mean width of the right and left lobules were 17.61-18.76 mm in female participants. The mean length of right and left auricles were 62.33-62.49 mm, the mean width of the right and left auricles were 33.60-33.96 mm, the mean length of right and left lobules were 18.49-18.11 mm, and the mean width of the right and left lobules were 19.19-20.47 mm in male participants.The data obtained from the present study may be useful for further studies. Also, the results may be useful for reconstructive surgeons to analyze the size and shape of the auricle.

KEY WORDS: Auricle; Craniofacial complex; Anthropometry; Lobulus auriculares.

INTRODUCTION

The auricle is an important component of the natural and symmetrical appearance of the human face and contributes to the aesthetic appearance of the face. It is also arecognizable feature of the face (Brucker *et al.*, 2003). Previously, the parts of the human body are examined anthropometrically and the measurements of these structures are investigatedin many studies (Jahanbin *et al.*, 2013; Ahmed & Omer, 2015; Bronfman *et al.*, 2015). The fact that these studies are carried out in different societies and still there is no consensus on the standards of ear anthropometric measurements (Farkas *et al.*, 1992). Anthropometry is considered to be an important method in the evaluation of facial features (Farkas, 1994). It is the basic method to determine the face malformation mathematically (Farkas *et al.*, 2007).The head and face anthropometry is a useful method in numerical determinations and very helpful for clinicians to define the shapelessness and to plan reconstructive procedures for surgeons (Oskarsdóttir *et al.*, 2008). Direct anthropometric or indirect anthropometric measurement methods are used in the studies such as three-dimensional laser scanning, two-dimensional photographic

evaluation, and radiographic measurements (Farkas *et al.*, 2005). The application of direct anthropometric methods is easy and has an advantage in terms of both cost and avoiding damage to the individuals.

Human face morphology varies depending on the age, race and sex. The harmony, symmetry, equality and proportion of the face are studied by many artists and surgeons (Tamir, 2014; Harrar *et al.*, 2018; Ghorbanyjavadpour & Rakhshan, 2019). Today, the facial rates developed by Leonardo da Vinci and Durer, some of the great Renaissance scholars, have been confirmed by orthodontists, jaw and facial surgeons (Malas *et al.*, 1997). There are few studies in the literature that examined the mean auricular anthropometry in Turkish young population (Bozkir *et al.*, 2004; Barut & Aktunc, 2006).

In this study, we aimed to reveal the anthropometric properties of the auricle in Turkish population. The collected measurements in the present study may provide a guide and database for craniofacial surgeons, clinicians, anthropologic

Department of Anatomy, Ondokuz MayısUniversity, Samsun, Turkey.

evaluation, and biomedical engineering. We believe that the present study may further provide beneficial effects in cosmetic and reconstructive auricular surgery in Turkish population.

MATERIAL AND METHOD

A total of 115 healthy students (56 males and 59 females) who were selected by the random sampling method between the ages of 18 and 30 (mean age was 21 for male, 22 for female) participated in the study. The ethical permission of the study was obtained from the Ondokuz Mayis University Medical Research and Ethics Commission. The volunteers were informed about "Informed Volunteer Form" and their consents were received. Participants were selected from healthy individuals who did not have a significant asymmetric appearance in the craniofacial and the auricle area and had no history of disease, congenital anomaly, trauma or surgery that could cause any change in auricular development. For the application of measurements, the volunteers were seated on a chair and heads were aligned in the Frankfurt horizontal plane (Barbera *et al.*, 2014; El Kattan *et al.*, 2018). The landmarks which are previously determined in the literature were used (Farkas *et al.*, 1992; Azaria *et al.*, 2003; Ahmed & Omer) (Table I). The landmarks that were used for measurement from the auricle are shown (Fig. 1). In the study, three different measurements were taken by the two different researchers from the head and face region using direct anthropometric measurement techniques to ensure the reliability of the results. Also, eight different anthropometric parameters were used for the measurement of the auricle (Table II).
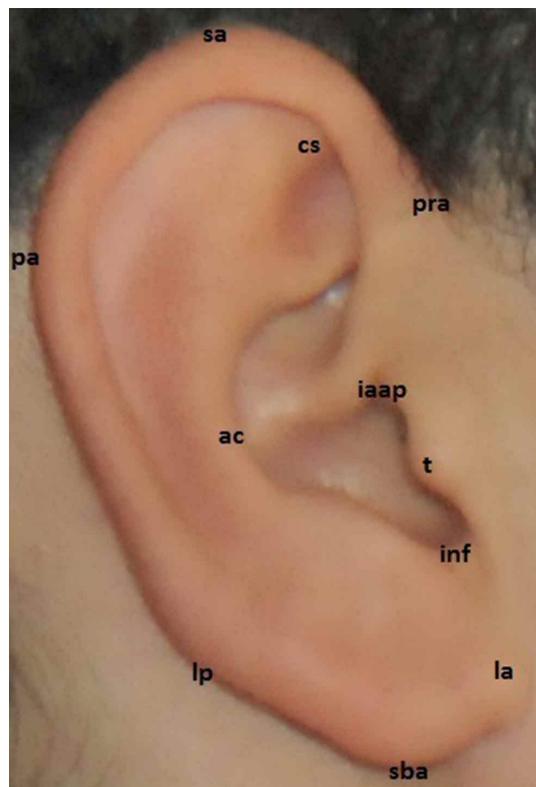

Fig. 1. Anthropometric landmarks of the auricle. sa: supraaurale, sba:subaurale, cs: concha superior, la:lobulus anterior, lp:lobulus posterior, pra:preaurale, pa:postaurale, ac:antihelical curvature, inf: incisura intertragica inferior, iaap: incisura anterior auris posterior

Table I. The landmarks and their explanations of the auricule.

Landmarks	Abbreviations	Definitions of the landmarks
Supraaurale	sa	The highest point of the auricle
Subaurale	sba	The lowest point of the earlobe
Preaurale	pra	Anterior point of the auricle close to the face
Postaurale	pa	Posterior point of the auricle away from the face
Concha superior	cs	Upper point of the concha
Lobulus anterior	la	Anterior point of the earlobe close to the face
Lobulus posterior	lp	The posterior point of the earlobe away to the face
Tragion	t	Deepest point of the notch just above the tragus of the ear.
Incisura intertragica inferior	inf	Inner lower notch point of the tragus
Incisura anterior auris posterior	iaap	Point of anterior notch of the auricle
Antihelical curvature	ac	The sharpest point of the antihelical inclination

Table II. The parameters and their explanations of the auricule.

Parameters	Definitions
Auricular length	The distance between the most superior part of the helix and the most inferior part of the lobule
Auricular width	The distance between the most anterior point and the most posterior point of the auricle
Lobular length	The distance from the most inferior part to the tragal notch base
Lobular width	Transvers measurement at the midpoint level of the lobule
Conchal length	The distance from the highest point of the antihelix_and the deepest point of the intertragic notch
Conchal width	The distance between incisura anterior auris posterior and strongest antihelical curvature
Protrusion at the tragal level	The horizontal distance between the posterior borders of the helix at the tragal level
Protrusion at the superaurale level	The transvers straight line from the superior point of the helix to the mastoid area at the superaurale level

Additionally, the auricular, lobular and conchal indices were calculated by using following formulas:

Auricular index: Auricular width*100/ Auricular length
Lobular index: Lobular width*100/ Lobular length
Conchal index: Conchal width*100/ Conchal length

One digital caliper (0-150mm x 0.05mm), one double sliding caliper (Holtain Ltd. UK), a depth gauge (Model 01140, Lafeyetta, USA; 2 cm, 0-60 cm), a leather measuring instrument (Model 01128, Lafeyetta, USA; 0.5 mm, 0-100 mm), an angle measurement set, a tape measure, a height measuring instrument (Model of Seca 220, Hamburg, Germany; 0.5cm) and a scale (Model of Seca 220, Hamburg, Germany; 0.1 kg Maximum: 200 kg) were used for measurements.

The data were analyzed by Statistical Package for Social Sciences (SPSS) statistical software (version 15.0; SPSS, Inc., Chicago, IL, USA). The mean values of the auricular measurements were calculated and analyzed to show statistical differences between the sexes. Independent sample ttest was used for comparing the values of sexes. The Wilcoxon test was used to compare the right and left auricle measurements in the same participants.The mean, the standard deviation, the maximum and minimum values of the auricles of the male and female participants were determined. The statistical significance level was accepted as p <0.05.

RESULTS

The anthropometric data and comparison of results for the right and left auricles of the participants are described in Table III. All sex-related changes of the auricular measurements were found to be statistically significant in males compared to females. The length and width of the right and left auricle, the right lobular width, the conchal width and length of the left auricle, protrusion at the tragal level of left auricle, protrusion at the supra- aurale level of right and left auricle showed a statistically significant difference (p<0.05). Lobular length of right and left auricle, lobular width of left auricle and the conchal length, the conchal width and the protrusion at the tragal level of the right auricle were larger in males than in females but did not have a significant difference (p>0.05).

The findings according to sex, all of the auricular indices apart from right lobular index had a statistically significant difference (p <0.05). Except for right lobular index, all of the indices were longer in males than in females (Table IV).

Table III. Mean auricular measurements (mm) of males and females.

Variables	Male		Female	
	Right	Left	Right	Left
Auricular length	6.23±0.36	6.20±0.54	5.83±0.42	5.85±0.38
Auricular width	3.41±0.56	3.40±0.90	3.04±0.33	2.97±0.27
Lobular length	1.85±0.62	1.81±0.62	1.61±0.22	1.65±0.21
Lobular width	1.92±0.28	2.05±0.59	1.76±0.26	1.88±0.21
Conchal length	2.64±0.33	2.65±0.33	2.51±0.26	2.51±0.26
Conchal width	2.03±0.36	2.09±0.39	1.89±0.18	1.87±0.19
Protrusion at the tragal level	1.67±0.36	1.69±0.33	1.51±0.28	1.51±0.28
Protrusion at the superaurale level	1.27±0.46	1.26±0.48	0.77±0.21	0.88±0.42

Table IV. Mean auricular ındices of males and females.

Variables	Male	Female
Right auricular index	54.10±6.84	52.42±6.53
Left auricular index	54.27±13.32	50.93±4.88
Right lobular index	110.44±26.37	111.37±20.23
Left lobular index	120.70±47.11	115.32±15.60
Right conchal index	78.01±15.30	76.18±12.08
Left conchal index	79.52±14.07	75.27±10.41

DISCUSSION

Auricular morphometry is important for cosmetic compliance of the face. Auricle and ear lobe are an element of beauty in many cultures and ethnic groups and also the earlobe is decorated with earrings and similar objects (Yotsuyanagi *et al.*, 2002). Auricular symmetry is very important for the smoothness of the aesthetic appearance of the face. As previously provided,there is no standard for the ear (Rubin *et al.*, 1962). Even within the same ethnic group, the shape and size of the auricle may vary.Knowledge of the anthropometric measurements of the auricle is very useful to analyze morphological differences, to determine the appropriate time for surgical corrections, and to establish standards for the designing of hearing aids and applications (Farkas *et al.*, 1992).

A number of reference points can be used to define the size, location and level of the auricle. Although visual

evaluation of the ear, such approaches are subjective and may vary from person to person. The normal size of the ear is more than half of the distance between the nasion and the gnathion. The auricule width is found to be more than half of the auricle length (Farkas *et al*., 1992). Standard measurements require the use of the standard measuring instruments. Faults in the measurement are caused by the use of incorrect measuring instruments or by not using them properly. The scales of the anthropometric measuring instruments are in the form of millimeters or degrees. The accuracy of the digital caliper is 0.01 mm and the error margin is 0.02 mm in our study.

In a study conducted in the north of Italy with the age of participants between 31-40 it was found that auricle lengths were 62.40 mm and 35.30 mm in the ears (Gualdi-Russo, 1998), length was 62.92 mm; left auricle length was 63.16 mm; right auricle width was 38,80 mm; the width of the left auricle was 38.17 mm(Ferrario *et al*., 1999). In our study, we found that the right auricle length was 60.28 mm and the length of the left auricle was 60.46 mm. According to these results, it can be said that the auricle of the northern people of Italy are longer and wider than the ear of the young participants in our study. Another group studied onSephardic Jewish individuals aged between 20-40 years old found that the length of the right ear lobe was 17.50 mm and the length of the left earlobe was 17.30 mm (Azaria *et al*.). In our study, we found that the length of the right earlobe was 17.23 mm and the left earlobe length was 17.26 mm. The ear lobe length of the Sephardic Jewish individuals is higher than the ear lobe length of the participants in our study. Also, another study reported that the right auricle inclination angle of 18 - 40 year old male in China was $14,80 \pm 6,1$ mm, while it was 25.31 ± 1.01 mm in our study (Wang *et al*., 2011). According to these results, it was determined that the inclination angle of the male participants in China is narrower than that of the young males in our study. The same study showed that the right conchal width of the male subjects was $17,80 \pm 2,0$ mm, while the right conchal width of the male subjects in our study was $20,29 \pm 0,36$ mm (Wang *et al*.). According to these results, it was found that the male population in China has narrower right conchal width than the young males of our study. A study conducted in the Indian population (Purkait & Singh, 2007) found that the protrusion at the level of left tragus was 24,80 mm. In our study, the protrusion of male individuals at the level of left tragus was 17.00 mm. The protrusion of the auricle of the individuals in India is quite higher when compared to the measurements taken from the individuals in our study. The same researcher group reported that the right auricle length was 58.20 mm, the left auricle length was 57.70 mm, the right auricle width was 34.10 mm, the left auricle width was 33.00 mm (Purkait & Singh). In our study, the length of the right auricle was 62.33

mm, the left auricle length was 62.49 mm, the right auricle was 33.60 mm and the left auricle was 33.96 mm. According to these results, the auricle of the young males in our study is longer than Purkait's study while they have the same auricular width. Ferrario *et al*., evaluated ear measurements of 314 adolescents and adults and the measurements of the males were statistically greater than females (Ferrario *et al*.). Similar results were also obtained in our study.

Mean values obtained in our study will be clinically beneficial in the facial aesthetics and the facial transplantation. In case of damage to the auricle formation, the average values of the ear in the relevant age and sex group are crucial in auricle surgical procedures. We live in the century of technology and information. The researchers should benefit from the technological developments. We recommend the use of a new reference point and different measurement technique in the auricle measurement using the opportunities provided by the technology.

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RESUMEN: La identificación personal se realiza principalmente mediante evaluación facial. El pabellón auricular tiene un papel clave en la evaluación y el reconocimiento del complejo craneofacial. El objetivo de este estudio fue proporcionar una base de datos normativa utilizando las medidas de la oreja entre hombres y mujeres jóvenes por métodos antropométricos. Se tomaron medidas antropométricas de 115 participantes, (56 hombres y 59 mujeres) entre 18 y 30 años. Los participantes eran estudiantse de la Facultad de Ciencias del Deporte Yasar Dogu de la Universidad Ondokuz Mayis. Cada participante firmó un formulario de consentimiento informado y luego participó en el estudio. Encontramos que en las mujeres la longitud media de las aurículas derecha e izquierda era de 58,30-58,52 mm, el ancho medio de las aurículas derecha y izquierdas era de 30,04 a 29,73 mm, la longitud media de los lóbulos derecho e izquierdo era de 16,05 a 16,45 mm y el ancho medio de los lóbulos derecho e izquierdo era de 17,61 a 18,76 mm. En los hombres, la longitud media de las aurículas derecha e izquierda era de 62,33-62,49 mm, el ancho medio de las aurículas derecha e izquierda era de 33,60-33,96 mm, la longitud media de los lóbulos derecho e izquierdo era de 18,49-18,11 mm, y el ancho medio de los lóbulos derecho e izquierdo era de 18,49-18,11 mm. Los datos obtenidos del presente estudio pueden ser útiles para estudios posteriores. Además, los resultados pueden ser útiles para que los cirujanos reconstructivos analicen el tamaño y la forma del pabellón auricular.

PALABRAS CLAVE: Aurícula; Complejo craneofacial; Antropometría; Lóbulos auriculares.

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Corresponding author
Emrah Altunsoy, M.D.
Department of Anatomy
Ondokuz Mayıs University
Samsun
55100
TURKEY

E-mail: emrah.altunsoy@omu.edu.tr