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Evaluation of the Radiological Anatomy of the Temporal Bone Air Spaces and Morphometric Analysis in Turkish Healthy Adults

Evaluación de la Anatomía Radiológica de los Espacios Aéreos del Hueso Temporal y Análisis Morfométrico en Adultos Turcos Sanos

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SUMMARY: The temporal bone is a complicate structure which located on the lateral skull. The objective of the present study was to determine the temporal bone air spaces' morphometry, morphology, and pneumatization in Turkish healthy adult people. This retrospective observational study was carried out from 82 subjects (47 males, 35 females) aged 18-69 years. The external auditory canal and related structures' diameters and the volume of these areas were evaluated. The means and standard deviations of the Meatus acusticus externus length (MAEL), meatus acusticus externus pars cartilaginea length (MAEcL), meatus acusticus externus pars ossea length (MAEoL), meatus acusticus externus pars cartilaginea surface (MAEcS), meatus acusticus externus pars ossea surface (MAEoS), meatus acusticus externus volume (MAEV), meatus acusticus externus pars cartilaginea volume (MAEcV), meatus acusticus externus pars ossea volume (MAEoV), processus mastoideus air cells volume (PMACV), cavum tympani volume (CTV), and temporale pneumatic spaces volume (OTPSV) were found as 23.21±3.70 mm, 12.69±3.72 mm, 7.80±3.70 mm, 669.89±107.7 mm^2, 267.50±30.51 mm^2, 743.50±119.6 mm^3, 971.97±156.69 mm^3, 419.51±48.67 mm^3, 5915.93±650.34 mm^3, 673.48±91.93 mm^3, 7813.34±717.49 mm^3 have found in 82 subjects, respectively. In this paper, the morphometric and volume properties of the temporal bone cavities measurements were significantly higher in males than females. These results may both provide reference values of Turkish healthy population, and lead to decrease potential surgical complications about temporal and mastoid regions.

KEY WORDS: Temporal bone; Pneumatization; Morphometry; Air spaces; External auditory canal.

INTRODUCTION

The temporal bone is a complex structure which located on the lateral skull that demonstrates a challenge in interpreting of anatomical details and diagnosis of several pathological conditions (Kheiralla, 2018; Szczepanek *et al*., 2022). This anatomical complex bone contains several important structures such as cranial nerves, vasculature, network of pneumatic spaces and middle ear (Isaacson, 2018). Moreoever, it is anatomically divided into tympanic, mastoid, petrous and squamous sections (Isaacson, 2018). The petromastoid part include of various component of ear and which is consist of plenty openings and canals that enter and exit the cranium. Furthermore, this part of bone consists of a compact bone and trabeculae that are having pneumatization (Isaacson, 2018; Mudgal *et al*., 2023). According to Allam F. (1969) who was first classify of pneumatization of temporal bone, it was claimed that there were 3 areas that: Mastoid , Petrous and Accessory pneumatizations (Mudgal *et al*., 2023). As we approach the present, Han *et al*. (2007), which is estimated temporal bone pneumatization to degree of pneumatization of sigmoid sinus and divided into four level that hypopneumatization, moderate pneumatization, good pneumatization and hyperpneumatization (Han *et al*., 2007). The pneumatization of the temporal bone begins with around the 24th week of gestation and develops till approximately the age of 10 years (Virapongse *et al*., 1985; Shin *et al*., 1999). Pneumatization is defined as a both being air cells via improving of mucosa to inward bone or presence of epithelial-lined air cells in cranial constituent that remains after the pneumatization process. Inconsistency of surface area and volume in these

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areas may originate from using various imaging technologies (Hill, 2011; Aladeyelu *et al*., 2022). Pneumatization have effected by many factors such as genetics, environment, nutrition, and diseases. For instance, decreasing of pneumatization of temporal bone is pointed in craniofacial disorders, Down syndrome, Pierre-Robin syndrome and Crouzon syndrome. On the otherhand, some diseases such as cystic fibrosis consequence in increasing of pneumatization of the temporal bone (Schuknecht & Gulya, 1986; Shimada *et al*., 1990; Shohat *et al*., 1993; Homøe *et al*., 1995; Imamura *et al*., 1995; Handzic-Cuk *et al*., 1999; Compos *et al*., 1999; Yildirim *et al*., 2000). Changeable level of pneumatization of the temporal bone has effects on pathogenesis of temporal bone diseases, such as cholesterol granuloma, otitis media, and cholesteatoma (Sadé, 1982; Turgut & Tos, 1992; Jackler & Cho, 2003).

External auditory canal, which is called meatus acusticus externus (MAE), is an S-shaped canal which occurs cartilaginous and osseous component. Lateral third of MAE is occurred cartilaginous while medial two-thirds is occurred of osseous (Isaacson, 2018). The morphology of the canal should have been known and determined for the diagnosis of ear diseases and planning the surgery because of the individual variations in this canal. Middle ear diseases are surgically treated via this canal (Ohira *et al*., 2022). However, according to MAE curvature, it may be needed to shave the bone in order to perform safety operations and to avoid the damage to the important structures (Harugop *et al*., 2008; Lade *et al*., 2014; Dedhia *et al*., 2018; Ohira *et al*., 2022).

The aim of this study was to determine the morphometric and volumetric measurements of temporal bone and related structures in Turkish healthy adult subjects.

MATERIAL AND METHOD

This retrospective observational study was carried out from 82 healthy subjects (47 males, 35 females) aged 18-69 years with Computed Tomography Angiography. Exclusion criteria were as follows; genetic disorders, intraventricular or subarachnoid hemorhage, a history of head trauma or central system infection a history of temporal bone pathology or trauma, a history of surgey via temporal bone and low quality of CT imaging. This study was approved by the Institutional Review Ethics Committee at Çukurova University (2023;133-40).

The measurements were made on the computer screen with an electronic caliper by a senior radiologist and anatomist two times and estimates were expressed as millimeters. After determined and collected of the images of the pneumatization of temporal bone, the volume was measured with a software system (mm; cm^2 and cm^3) (Szczepanek *et al*., 2022).

Measurements on selected were performed as following.

- Meatus acusticus externus length (MAEL)
- Meatus acusticus externus pars cartilaginea length (MAEcL)
- Meatus acusticus externus pars ossea length (MAEoL)
- Meatus acusticus externus pars cartilaginea surface (MAEcS)
- Meatus acusticus externus pars ossea surface (MAEoS)
- Meatus acusticus externus volume (MAEV)
- Meatus acusticus externus pars cartilaginea volume (MAEcV)
- Meatus acusticus externus pars ossea volume (MAEoV)
- Processus mastoideus air cells volume (PMACV)
- Cavum tympani volume (CTV)
- Os temporale pneumatic spaces volume (OTPSV)

Additionally, data were evaluated according to sex.

Statistical analysis. The SPSS 21.0 program was used for statistical analysis of the measurement results. In all statistical analyses; p value under 0.05 was considered statistically significant. Furthermore, Pearson Correlation Test was used to compare the measurements with each other.

RESULTS

The values of the temporal bone and related parameters were shown in Table I. The means and standard deviations of the MAEL, MAEcL, MAEoL, MAEcS, MAEoS, MAEV, MAEcV, MAEoV, PMACV, CTV, OTPSVD were as 23.21±3.70 mm, 12.69±3.72 mm, 7.80±3.70 mm, 669.89±107.73 mm^2, 267.50±30.51 mm^2, 743.50±119.56 mm^3, 971.97±156.69 mm^3, 419.51±48.67 mm^3, 5915.93±650.34mm^3, 673.48±91.93 mm^3, 7813.34±717.49 mm^3 have found in subjects, respectively.

Data were divided according to sex and shown in Table II. There were found significant differences in all measurements except CTV ($p<0.05$). Furthermore males measurements were higher than females. Pearson correlation test was used to compare the measurements with each other and findings shown in Table III. Since the length, volume and surface measurements are related to each other, the correlation coefficient was high in the comparison of many measurements. However there is low and moderate positive a correlation between length, surface and volume of MEA to PMACV, CTV, OTPSVD ($0.2<r<0.6$). Additionally, there is very low coefficent and no statistically significant between PMACV to CTV ($r=0.117$, $p=0.294$).

Table I. The morphometric and volumetric measurements of the temporal bone air spaces and related regions

Measurements	Mean ±SD	Min	Max
MAEL (mm)	23.21±3.70	16.74	29.04
MAEcL (mm)	12.69±3.72	6.21	18.51
MAEoL (mm)	7.80±3.70	1.29	13.64
MAEcS (mm^2)	669.89±107.73	482.72	840.00
MAEoS (mm^2)	267.50±30.51	203.87	326.59
MAEV (mm^3)	743.50±119.56	535.54	930.00
MAEcV (mm^3)	971.97±156.69	699.60	1246.00
MAEoV (mm^3)	419.51±48.67	319.80	512.30
PMACV (mm^3)	5915.93±650.34	3297.00	7014.00
CTV (mm^3)	673.48±91.93	341.70	804.40
OTPSV (mm^3)	7813.34±717.49	5981.31	8881.87

MAEL: Meatus acusticus externus length; MAEcL: Meatus acusticus externus pars cartilaginea length; MAEoL: Meatus acusticus externus pars ossea length; MAEcS: Meatus acusticus externus pars cartilaginea surface; MAEoS: Meatus acusticus externus pars ossea surface; MAEV: Meatus acusticus externus volume; MAEcV: Meatus acusticus externus pars cartilaginea volume; MAEoV: Meatus acusticus externus pars ossea volume; PMACV: Processus mastoideus air cells volume; CTV: Cavum tympani volume; OTPSV: Os temporale pneumatic spaces volume; mm:milimeter; mm^2:milimeter square; mm^3:cubic milimeter.

DISCUSSION

Having a well understanding of the variation presence in the temporal bone cavities' morphometric and morphologic features can provide several advantages such as choosing the accurate surgical approach for various otorhinolaryngological procedures. So, a surgeon can use this anatomical knowledge, or reference points, or morphometric values when performing an approach on EAC or tympanic membrane or mastoid cavity including mastoidectomy, and myringoplasty (Ayache *et al*., 2006; Standring *et al*., 2008; Jadhav *et al*., 2014; Yu *et al*., 2015). The temporal bone, located on the lateral skull that could be ignored because of its size but its anatomical complexity, could pose a challenge in interpreting anatomical details and diagnosis of various pathological conditions. Moreover, the pneumatization is exposed to many variations at different periods of life, in different individuals, and in the same individual under different conditions (Schuknecht & Gulya, 1986; Shimada *et al*., 1990; Shohat *et al*., 1993; Homøe *et al*., 1995; Imamura *et al*., 1995; Handzic-Cuk *et al.*, 1999; Compos *et al*., 1999; Yildirim *et al*., 2000; Aladeyelu *et al*., 2022). The temporal bone pneumatization determines the course of disease in middle ear surgery and is a factor that can be taken into account when planning operations involving this region (Aladeyelu *et al*., 2022). The mastoid air cells have a key role to physiology of the middle ear which have been studied principally in terms of volumetric point of view since mastoid cavity has been admitted as an air reservoir (Hug, 1986). Studies which have been performed to aim of correlation between mastoid pneumatization and middle ear disease showed that there is a risk factor for developing of various middle-ear diseases owing to a hypopneumatized mastoid air cells (Hug, 1986; Sadé & Hadas, 1979; Tos & Stangerup, 1984; Ikarashi *et al*., 1996).

Studies have shown that the mastoid pneumatization might be a prognostic indicator in otitis media because of known that infection of the middle ear in early life suppresses the normal development of pneumatization of the mastoid bone (Sadé & Hadas, 1979; Tos & Stangerup, 1984). Furthermore, one of the features mastoid cavity is be an active space for gas exchange because of the air cell system

Table II. Distribution of temporal bone pneumatization measurements results according to sex.

	Male (n=47)			Female (n=35)			
Measurements	Mean±SD	Min	Max	Mean±SD	Min	Max	p
MAEL (mm)	25.73±2.30	20.00	29.04	19.83±2.24	16.74	26.00	<0.001
MAEcL (mm)	15.19±2.33	9.00	18.51	9.33±2.31	6.21	15.85	<0.001
MAEoL (mm)	10.32±2.24	5.00	13.64	4.40±2.29	1.29	10.53	<0.001
MAEcS (mm^2)	742.22±68.19	562.04	840.00	572.75±66.40	482.72	750.00	<0.001
MAEoS (mm^2)	284.49±23.23	217.00	326.59	244.69±23.50	203.87	325.00	<0.001
MAEV (mm^3)	824.05±75.01	623.00	930.00	635.33±73.69	535.54	840.00	<0.001
MAEcV (mm^3)	1077.38±98.75	816.00	1246.00	830.42±96.50	699.60	1100.00	<0.001
MAEoV (mm^3)	446.10±38.50	340.00	512.30	383.81±36.74	319.80	510.00	<0.001
PMACV (mm^3)	6123.92±758.80	3297.00	7014.00	5636.63±297.48	5100.00	6193.00	<0.001
CTV (mm^3)	689.78±112.76	341.70	804.40	651.59±45.51	590.00	793.00	0.062
OTPSV (mm^3)	8056.60±820.82	5981.31	8881.87	7486.67±351.04	6796.30	8600.00	<0.001

MAEL: Meatus acusticus externus length; MAEcL: Meatus acusticus externus pars cartilaginea length; MAEoL: Meatus acusticus externus pars ossea length; MAEcS: Meatus acusticus externus pars cartilaginea surface; MAEoS: Meatus acusticus externus pars ossea surface; MAEV: Meatus acusticus externus volume; MAEcV: Meatus acusticus externus pars cartilaginea volume; MAEoV: Meatus acusticus externus pars ossea volume; PMACV: Processus mastoideus air cells volume; CTV: Cavum tympani volume; OTPSV: Os temporale pneumatic spaces volume; mm:milimeter; mm^2:milimeter square; mm^3:cubic milimeter

Table III. The relationship between the measurements according to Pearson correlation analysis.

Correlation Significance		Sex	MAEL	MAEcL	MAEoL	MAEcS	MAEoS	MAEV	MAEcV	MAEoV	PMACV	CTV	OTPSV
Sex	r	-	-0.792	-0.784	-0.795	-0.783	-0.649	-0.786	-0.784	-0.637	-0.373	-0.207	-0.395
	p		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MAEL (mm)	r	-0.792	-	0.999	0.990	0.989	0.744	0.998	0.997	0.741	0.367	0.238	0.395
	p	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MAEcL (mm)	r	-0.784	0.999	-	0.999	0.990	0.750	0.980	0.970	0.745	0.356	0.230	0.391
	p	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MAEoL (mm)	r	-0.795	0.990	0.999	-	0.900	0.740	0.910	0.910	0.743	0.350	0.232	0.391
	p	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MAEcS (mm^2)	r	-0.783	0.989	0.990	0.900	-	0.749	0.900	0.920	0.747	0.358	0.241	0.395
	p	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MAEoS (mm^2)	r	-0.649	0.744	0.750	0.740	0.749	-	0.750	0.749	0.994	0.334	0.392	0.484
	p	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	0.002	<0.001	<0.001
MAEV (mm^3)	r	-0.786	0.998	0.980	0.910	0.900	0.750	-	0.990	0.749	0.359	0.242	0.397
		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	0.028	0.010
MAEcV (mm^3)	r	-0.784	0.997	0.970	0.920	0.910	0.749	0.990	-	0.747	0.345	0.241	0.397
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	0.029	<0.001
MAEoV (mm^3)	r	-0.637	0.741	0.745	0.743	0.747	0.994	0.749	0.747	-	0.331	0.395	0.488
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		0.002	<0.001	=0.001
PMACV (mm^3)	r	-0.373	0.367	0.356	0.350	0.358	0.334	0.359	0.345	0.331	-	0.117	0.635
	p	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.002		0.294	0.003
CTV (mm^3)	R	0.207	0.238	0.230	0.232	0.241	0.392	0.242	0.241	0.395	0.117	-	0.815
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.029	<0.001	0.294		<0.001

MAEL: Meatus acusticus externus length; MAEcL: Meatus acusticus externus pars cartilaginea length; MAEoL: Meatus acusticus externus pars ossea length; MAEcS: Meatus acusticus externus pars cartilaginea surface; MAEoS: Meatus acusticus externus pars ossea surface; MAEV: Meatus acusticus externus volume; MAEcV: Meatus acusticus externus pars cartilaginea volume; MAEoV: Meatus acusticus externus pars ossea volume; PMACV: Processus mastoideus air cells volume; CTV: Cavum tympani volume; OTPSV: Os temporale pneumatic spaces

give a chance to allow gas swap with submucosal capillary (Ikarashi *et al*., 1996).

Computed Tomography (CT) is both the best and common radiographic method for evaluating the mastoid pneumatization. Also, this method plays an important role in field of dentistry to identify early changes in the temporal bone and to make appropriate referrals to specialist to avoid long term functional disability (Hug, 1986; Jadhav *et al*., 2014; Szczepanek *et al*., 2022).

In this paper, we measured the morphology external auditory canal, and related structures and the volume of these areas. Mastoid air cell is an air reservoir for the middle ear and mastoid air cell volume determines the reservoir capacity. The mastoid air cell size is essential for the planning chronic ear and middle ear surgeries. The mean values of mastoid air cell volume was measured as 10430 mm^3 range from 6250 to 20520 mm^3 in healthy Korean subjects aged between 20 and 53years (Hug, 1986). Also, in another Korean study of Lee *et al*. (2005) the mastoid air cells continue to grow untill 30 years in females (7320.6 mm^3) and 29 years in males (8211.7 mm^3). Moreover, same values were measured as 5915.93mm3 (in females, 5636.63 mm^3; in males, 6123.92) (Lee *et al*., 2005). The corresponding value was reported as 5810.50, mm^3 in Polish healthy females and 6957.62 mm^3 in Polish healthy males (median age of 49.7 years) (Szczepanek *et al*., 2022). We found some differences and similarities in the mean values of mastoid air cell volume of above studies with our population. According to this data our result is lower than Korean healthy population, whereas this result is similar to Polish subjects. These differences may originate from age, sex, race, method used, puberty, and nutrition. Additionally, nutrition is an important factor for undevelopped countries because of low income which has high rated otitis media. Because these have lower or smaller mastoid air cell.

Furthermore, until puberty period, females had larger mastoid air cell size because of females' early initiation of general physical growth. However, after puberty the mastoid air cells size in males became larger than females (Lee *et al*., 2005; Aladeyelu *et al*., 2022).

It is mentioned about relationship's presence of temporal bone pneumatization degree and several pathologies such as atelactasis, otitis media, and cholesteatoma. Inadequacy in temporal bone pneumatization is a sign of increased incidence and poor prognosis of these pathologies. Also, this situation originates form temporal bone' important functions such as pressure buffer, gas reserve and shock absorption spaces. Pneumatization may provide a survival benfit serving to protect surronding vital organs like cochlea, vestibule, facial nerves and carotid artery. Moreover, a study conducted by 54 Korean subjects suffer from temporal bone fracture investigated the effects of clinical conditions related to ear on temporal bone pneumatization. In same study, it is reported that temporal bone pneumatization play a role as a shock absorber to defend surrounding essential structures in trauma, and level of temporal bone pneumatization of patiens with or without sensorineural hearing loss have statistical difference. Furthermore, the severity of the hearing loss detemines the temporal bone pneumatization. Increase in hearing loss leads to decrease in temporal bone pneumatization (Kang *et al*., 2019). Increase in temporal bone pneumatization prevents the severe complications related temporal bone's development. In a studying consisting of Polish healthy subjects, the mean value of temporal bone pneumatic space volume was found as 9315.45 mm^3 in males and in females 7644.75 mm^3, respectively (Szczepanek *et al*., 2022). Furthermore, the corresponding values were 8056.60 mm^3 in males and 7486.67 mm^3 in females, respectively in this paper. Our dimension of females was close to Polish females, whereas the Polish males' measurement was higher than ours.

EAC is a pathway for transmitting acoustic signals to the tympanic membrane. The EAC is on average 2-3cm in length. The curved overhang of the EAC can obstruct the field of vision, affect diagnosis, treatment and render operation on the middle ear difficult (Sadé & Hadas, 1979; Singh *et al*., 2019). External auditory canal is composed of lateral cartilaginous portion and medial osseous portion (Singh *et al*., 2019). Knowledge about the External auditory canal (EAC) morphology is of great importance when performing procedures such as tympanic membrane surgical repairs in this region (Szczepanek *et al*., 2022). Since various vital structures adjacent EAC such as facial nerve or jugular bulb, it is necessary to caution to prevent damage (Ohira *et al*., 2022). The morphometry of external auditory canal is important for some tools about ears such as in-ear headphones, earplugs, hearing aid (Yu *et al*., 2015). Moreover, human factors and ergonomics play a very important role in mass customization of several in the canal products and for defining average sizes for canal plasty operations (Singh *et al*., 2019). Studies detected EAC narrowings in radiologic images may be valuable for differential diagnosis of such pathologies. The length of the human ear canal is thereabout among 2.3 and 2.97 cm or 2-3 cm according to both classical anatomy resources and literature (Yost, 2001; Singh *et al*., 2019; Szczepanek *et al*., 2022). Also, Yu *et al*. (2015) demonstrated that male external auditory canal length was longer than female and there were statistically significant difference by sex (Yu *et al*., 2015; Szczepanek *et al*., 2022). According to this data our result is similar to these population. Additionally, the current study showed that there is sexual dimorphisim in the EAC morphometric and volumetric features. Females, on average, had lower volumes, smaller total surface area, and shorter length of EAC. Additionally, the main significance of these differences between men and women lies in the decision as to which of the three accepted methods of surgical repair such as endadural, postdural or permeatal, should be used. The other importance of EAC is about squamous cell carcinoma which affects the temporal bone including EAC of this area, or EAC cholesteatoma. This condition requires surgery.

In summary, when we compare our findings with other populations, it is seen that there are some differences as well as some similarities. It can be said that many factors such as race, genetic and demographic variables (age, gender, etc.) may play a role in these differences. For this reason, this study has revealed anatomical parameters that should be taken into consideration especially in the evaluation of temporal bone and external auditory canal problems and important normative values for the Turkish population. We believe that the data obtained can provide important reference values to clinicians about this region

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RESUMEN: El hueso temporal es una compleja estructura ubicada en el parte lateral del cráneo. El objetivo del presente estudio fue determinar la morfometría, morfología y neumatización de los espacios aéreos del hueso temporal en individuos adultos turcos sanos. Este estudio observacional retrospectivo que se llevó a cabo en 82 sujetos (47 hombres, 35 mujeres) de entre 18 y 69 años. Se evaluaron los diámetros del meato acústico externo y las estructuras relacionadas y el volumen de estas áreas. Las medias y las desviaciones estándar

de la longitud del meato acústico externo (MAEL), la longitud de la parte cartilaginosa del meato acústico externo (MAEcL), la longitud de la parte ósea del meato acústico externo (MAEoL), la superficie de la parte cartilaginosa del meato acústico externo (MAEcS), la superficie de la parte ósea del meato acústico externo (MAEoS), volumen del meato acústico externo (MAEV), volumen de la parte cartilaginosa del meato acústico externo (MAEcV), volumen de la parte ósea del meato acústico externo (MAEoV), volumen de las células aéreas del proceso mastoideo (PMACV), volumen del cavum tympani (CTV) y el volumen de los espacios neumáticos temporales (OTPSV) se encontró como 23,21 ± 3,70 mm, 12,69 ± 3,72 mm, 7,80 ± 3,70 mm, 669,89 ± 107,7 mm^2, 267,50 ± 30,51 mm^2, 743,50 ± 119,6 mm^3, 971,97 ± 156,69 mm^3, 419,5. 1±48,67 mm^3 , 5915,93 ± 650,34 mm^3, 673,48 ± 91,93 mm^3, 7813,34 ± 717,49 mm^3, respectivamente. En este artículo, las propiedades morfométricas y de volumen de las mediciones de las cavidades del hueso temporal fueron significativamente mayores en hombres que en mujeres. Estos resultados pueden proporcionar valores de referencia de la población sana turca y conducir a una disminución de las posibles complicaciones quirúrgicas en las regiones temporal y mastoidea.

PALABRAS CLAVE: Hueso temporal; Neumatización; Morfometría; Espacios aéreos; Meato acústico externo.

REFERENCES

Aladeyelu, O. S.; Olaniyi, K. S.; Olojede, S. O.; Mbatha, W. E.; Sibiya, A. L. & Rennie, C. O. Temporal bone pneumatization: A scoping review on the growth and size of mastoid air cell system with age. *PLoS One, 17(6)*:e0269360, 2022.

Ayache, D.; Trabalzini, F.; Bordure, P.; Gratacap, B.; Darrouzet, V.; Schmerber, S.; Lavieille, J. P.; Williams, M. & Lescanne, E. Serous otitis media revealing temporal en plaque meningioma. *Otol. Neurotol., 27(7)*:992-8, 2006.

Dedhia, K.; Yellon, R. F.; Branstetter 4th, B. F. & Best, M. External auditory canal: Inferior, posterior-inferior, and anterior canal wall overhangs. *Int. J. Pediatr. Otorhinolaryngol., 109*:138-43, 2018.

Han, S. J.; Song, M. H.; Kim, J.; Lee, W. S. & Lee, H.K. Classification of temporal bone pneumatization based on sigmoid sinus using computed tomography. *Clin. Radiol., 62(11)*:1110-8, 2007.

Handzic-Cuk, J.; Cuk, V. & Gluhinic, M. Mastoid pneumatization and aging in children with Pierre-Robin syndrome and in the cleft palate population out of syndrome. *Eur. Arch. Otorhinolaryngol., 256(1)*:5-9, 1999.

Harugop, A. S.; Mudhol, R. S. & Godhi, R. A. A comparative study of endoscope assisted myringoplasty and micrsoscope assisted myringoplasty. *Indian J. Otolaryngol. Head Neck Surg., 60(4)*:298-302, 2008.

Hill, C. A. Ontogenetic change in temporal bone pneumatization in humans. *Anat. Rec. (Hoboken), 294(7)*:1103-15, 2011.

Homøe, P.; Lynnerup, N. & Skovgaard, L. T. Pneumatization and otitis media in Greenlandic Inuit before European colonization. *J. Otolaryngol., 24(6)*:330-5, 1995.

Hug, J. E. A planimetric study of temporal bone pneumatization. Arch. *Otorhinolaryngol., 243(5)*:304-8, 1986.

Ikarashi, F.; Nakano, Y. & Okura, T. Pneumatization of the tympanic bulla after blockage of the ventilation route through the Eustachian tube in the pig. *Ann. Otol. Rhinol. Laryngol., 105(10)*:784-90, 1996.

Imamura, Y.; Mizutani, T. & Iino, Y. Development of mastoid pneumatization of the children with Down's syndrome. *Int. J. Pediatr. Otorhinolaryngol., 16(2)*:55-8, 1995.

Isaacson, B. Anatomy and surgical approach of the ear and temporal bone. *Head Neck Pathol., 12(3)*:321-7, 2018.

Jackler, R. K. & Cho, M. A new theory to explain the genesis of petrous apex cholesterol granuloma. *Otol. Neurotol., 24(1)*:96-106, 2003.

Jadhav, A. B.; Fellows, D.; Hand, A. R.; Tadinada, A. & Lurie, A. G. Classification and volumetric analysis of temporal bone pneumatization using cone beam computed tomography. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol., 117(3)*:376-84, 2014

Kang, T. K.; Ha, R.; Oh, J. H. & Sunwoo, W. The potential protective effects of temporal bone pneumatization: A shock absorber in temporal bone fracture. *PLoS One, 14(5)*:e0217682, 2019.

Kheiralla, O. A. M. Anatomical characteristics of temporal bone on computerized tomography. *IOSR J. Dent. Med. Sci., 17(5)*:88-96, 2018.

Lade, H.; Choudhary, S. R. & Vashishth, A. Endoscopic vs microscopic myringoplasty: a diferent perspective. *Eur. Arch. Otorhinolaryngol., 271(7)*:1897-902, 2014.

Lee, D. H.; Jun, B. C.; Kim, D. G.; Jung, M. K. & Yeo, S. W. Volume variation of mastoid pneumatization in different age groups: a study by three-dimensional reconstruction based on computed tomography images. *Surg. Radiol. Anat., 27(1)*:37-42, 2005.

Mudgal, P.; Smith, D. & Hacking, C. *Temporal bone*. Web Site, Radiopaedia.org, 2023.

Ohira, S.; Komori, M.; Nakamura, M.; Matsuura, K.; Osafune, H.; Kajiwara, R. & Wada, K. Morphological relationships between external auditory canal and vital structures of tympanic cavity. *Head Face Med., 18(1)*:35, 2022.

Sadé, J. & Hadas, E. Prognosis in SOM relative to pneumatization. *Arch. Otolaryngol., 225(1)*:39-44, 1979.

Sadé, J. Treatment of retraction pockets and cholesteatoma. *J. Laryngol. Otol., 96(8)*:685-704, 1982.

Schuknecht, H. F. & Gulya, A. J. *Anatomy of the Temporal Bone with Surgical Implications*. Philadelphia, Lea & Febiger, 1986.

Shimada, S.; Yamaguchi, N. & Honda, Y. Eustachian tube function and mastoid pneumatization. *Acta Otolaryngol. Suppl., 471*:51-5, 1990.

Shin, J. A.; Cho, Y. B. & Ahn, O. K. A study of the position of the mastoid antrum of Korean people in the temporal bone CT. *Korean J. Otolaryngol., 42*:1184e7, 1999.

Shohat, M.; Flaum, E.; Cobb, S. R.; Lachman, R.; Rubin, C.; Ash, C. & Rimoin, D. L. (1993). Hearing loss and temporal bone structure in achondroplasia. *Am. J. Med. Genet., 45(5)*:548-51, 1993.

Singh, P.; Mittal, M. K.; Mathur, N. N.; Sinha, M.; Panesar, S.; Khatri, G. & Thukral, B. B. Morphometric analysis of the external auditory canal by computed tomography in Indian population. *Indian J. Otolaryngol. Head Neck Surg., 71(2)*:1115-22, 2019.

Standring, S.; Borley, N. R. & Gray, H. *Gray's anatomy: the anatomical basis of clinical practice*. 40th ed. Edinburgh, Churchill Livingstone 2008.

Szczepanek, E.; Ostrowski, P.; Rams, D.; Bonczar, M.; Batko, J.; Wojciechowski, W.; Niemczyk, K.; Walocha, J. & Koziej, M. Air spaces of the temporal bone: a morphometric analysis with clinical implications. *Folia Morphol.* (Warsz.), 2022. Epub ahead of print. Doi: https://www.doi.org/10.5603/FM.a2022.0093

Tos, M. & Stangerup, S. E. Mastoid pneumatization in secretory otitis. Further support for the environmental theory. *Acta Otolaryngol., 98(1-2)*:110-8, 1984.

Turgut, S. & Tos, M. Correlation between temporal bone pneumatization, location of lateral sinus and length of the mastoid process. *J. Laryngol. Otol., 106(6)*:485-9, 1992.

Virapongse, C.; Sarwar, M.; Bhimani, S.; Sasaki, C. & Shapiro, R. Computed tomography of temporal bone pneumatization: 1. Normal pattern and morphology. *AJR Am. J. Roentgenol., 145(3)*:473-81, 1985.

Yildirim, N.; Sone, M.; Mutlu, C.; Schachern, P. A.; Paparella, M. M. & Le, C. T. Histopathologic features of the temporal bone in patients with cystic fibrosis. *Arch. Otolaryngol. Head Neck Surg., 126(1)*:75-8, 2000.

Yost, W. A. *Fundamentals of hearing: An introduction*. New York, Holt, Rinehart and Winston, 2001. pp.1714-7.

Yu, J. F.; Lee, K. C.; Wang, R. H.; Chen, Y. S.; Fan, C. C.; Peng, Y. C.; Tu, T. H.; Chen, C. I. & Lin, K. Y. Anthropometry of external auditory canal by non-contactable measurement. *Appl. Ergon., 50*:50-5, 2015.

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