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Internal Acoustic Opening: Different Osseous Landmarks and their Clinical Implications

Poro Acústico Interno: Diferentes Hitos Óseos y sus Implicaciones Clínicas

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SUMMARY: Internal acoustic opening is a space that opens to facies posterior of the petrous piece of temporal bone that goes inside facial nerve, vestibulocochlear nerve, intermedial nevre and labyrinthine artery. The purpose of this study is the assessment of internal acoustic opening from a morphometric perspective, determination of the shape of the hole and determination of the distance to some important anatomic formations. This study is conducted on 166 temporal bones with unknown sex formation which are part of the skull collection in NEU and KTO Karatay University, Anatomy Department. In this study, the vertical and diameter of internal acoustic meatus, its distance to the bottom and top sides of posterior surface of the petrous part, its distance to groove for superior sagittal sinus and its distance to apex were measured. Moreover, in this study internal acoustic opening spaces are categorized into six groups as round, oval, U-shaped, fissure, irregular and V shape. Digital caliper was used for internal acoustic meatus measurements. While the vertical horizontal diameters and distance to groove for superior sagittal sinus of internal acoustic opening on the right side are 4.12 mm, 6.83 mm and 19.64mm respectively, they are 4.56 mm, 7.10 mm and 21.06 mm on the left side respectively. We have observed in this study, 37.3 % of the internal acoustic opening as round, 34.3 % as oval, 6.6 % as U-shaped, 6.6 % as fissure, 12.7 % as irregular and 2.4 % as V-shaped. We believe that these measurements can provide guidance and help in surgical procedures

KEY WORDS: Groove for superior sagittal sinus; Cranium; Internal acoustic opening; Temporal bone.

INTRODUCTION

The internal auditory meatus (IAM) is the canal that provides a connection between the posterior cranial fossa and the internal ear. The canal opens onto the posterior surface of the petrous part of the temporal bone, and this gap is called the internal acoustic pore (PAI). The facial, vestibulocochlear, intermediate nerve and the labyrinthine artery pass through this gap with blunt margins (Rubinstein *et al*. 1996, Drake *et al*., 2009).

The top side of the petrous part of the temporal bone is called the apex of the petrous part (apex partis petrosae). The posterior and slightly upward face of the petrous part is called the facies posterior partis petrosae. The margin formed by the anterior and posterior surface is called the superior margin of the petrous part (margo superior partis petrosae), and the superior petrosal sinus sulcus extends along this margin (Sennaroglu & Slattery 2003, Rubinstein *et al*., 1996, Drake *et al*., 2009).

Recognition of the exact location of the IAM to the posterior cranial fossa and other close formations is very important for surgical procedures. There are many precautions required to be taken to prevent hearing loss during acoustic neuroma surgery. The inner ear, as well as the cochlear nerve, should be protected. Along with the normal anatomy of the IAM, variations should also be recognized. Surgically, the IAM is accessible through the retrosigmoid approach, or trans labyrinthine method, which is performed from the posterior cranial fossa. Many surgeons who perform acoustic neuroma surgery prefer the removal of the IAM from the posterior side through a suboccipital retrosigmoid approach as an easier and more reliable method. The reason for a preference for a medial cranial fossa approach rather than a posterior cranial fossa approach is due to the more complex formation of the anatomic structures in that area (Kolagi *et al*., 2010).

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Vestibular schwannoma are located on the cerebellopontine edge. The surgical technique used for these tumours is usually from the IAM (Gupta & Gupta 2009). The majority of the studies performed on the IAM consist of clinical case reviews (Blevins *et al*., 1994; Marques *et al*., 2012). Some studies have been conducted on cadavers for clinical anatomy (Kolagi *et al*., 2010). Dry skulls or dry temporal bones were used to determine morphometric characteristics of the IAM and PAI in some studies. Along with recent developments in radiological imaging techniques, magnetic resonance imaging (MRI) and computed tomography (CT) have started to be used to high light the anatomy of the inner ear tract (Rubinstein *et al*., 1996; Marques *et al*., 2012; Day *et al*., 1994).

The aim of the present study was to reveal the distance between anatomic formations on the posterior wall during surgical procedures of the IAM through a posterior approach. Our objective is to make a contribution on morphometric characteristics of the IAM and PAI, serving as a resource in literature studies, as well as typing and determining the opening forms of the IAM as a guide for further surgical procedures. We also evaluated the normal dimensions related to the targeted internal and IAM in a Turkish population independent of gender and dry bone.

MATERIAL AND METHOD

In the present study, 114 temporal bones of 57 craniums and 52 isolated (32 left, 28 right) bones belonging to the collection of the Anatomy Laboratory of KTO Karatay and Necmettin Erbakan University were studied. The present study was conducted on the posterior face of 166 temporal bones in total. The permit required for the study was obtained from the Ethical Committee for Non-Drug and Non-Medical Device Researches of KTO Karatay University, decision number 2018/016. The sex of all the subjects from which the temporal bones in our study were used is not clear. This is because the bones studied were from skulls obtained from excavations in Central Anatolia. The measurements were taken by a digital compass with a sensitivity of 0.1 mm and all values were provided in millimetres (Fig. 1).

The present study was planned in 2 stages (Morphometric measurements and morphological classification).

Morphometric measurements

PAIV: Vertical (V) or superior-inferior diameter of the PAI;
PAIH: Horizontal (H) or anterior-posterior diameter of the PAI;
PAIA: The distance between the PAI and the top of the jugular fossa (A);
PAIU: The distance between PAI and the back side of the superior margin of the petrous part of the upper edge (U);
PAIS: The distance between the PAI and the sinus of the sigmoid sulcus (S);
PAIVe: The distance from the outer edge of the PAI to the external aperture of the vestibular aqueduct (Ve);
PAIAp: The distance between the PAI and petrous apex (Ap; Fig. 2).

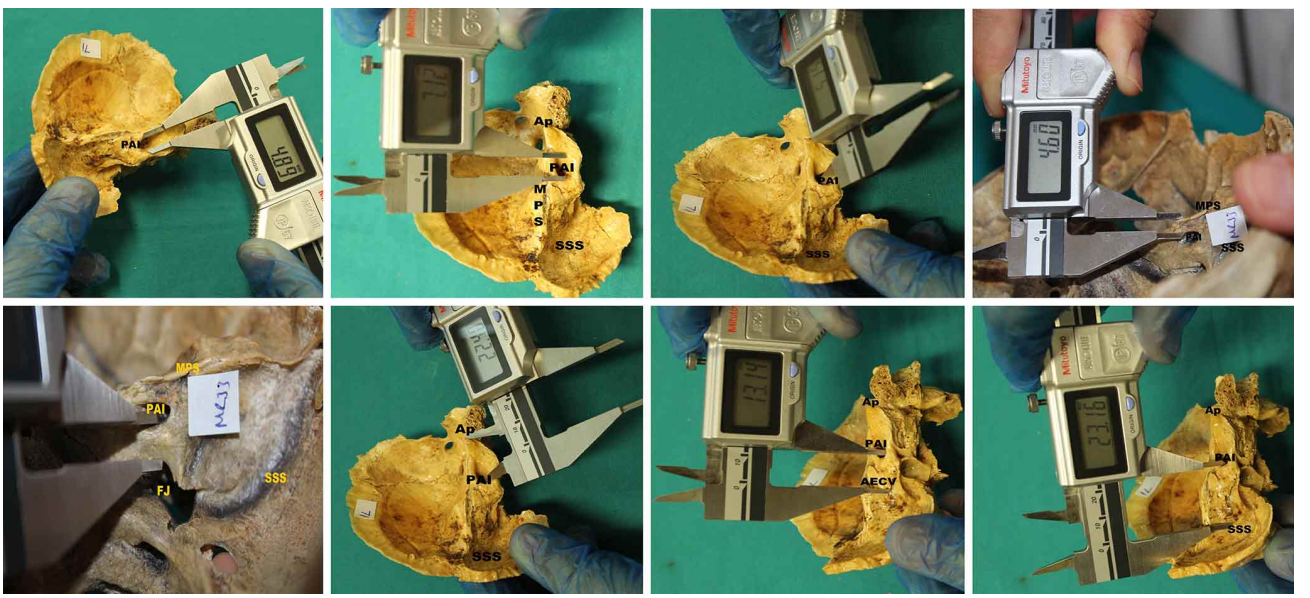

Fig. 1. The morphomoteric measurements of PAI with digital caliper (MPS: The superior magrin of the petrous part, PAI: The internal acoustic opening, FJ: The jugular foramen, SSS: The groove of the sigmoid sinus, Ap: The apex of the petrous part, AECV: External opening of the vestibular canaliculi).

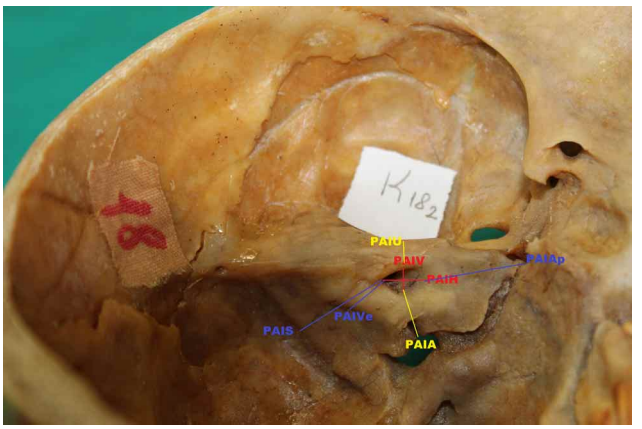

Fig. 2. Posterior surface of left temporal bone showing various measurements. (PAIV: Vertical diameters of internal auditory canal, PAIH: Horizontal diameters of internal auditory canal, PAIS: From the uppermost point on anterior wall of sigmoid sulcus to lateral wall of internal auditory canal, PAIU: Mid point of upper margin of internal auditory canal to superior border of petrous bone, PAIA: Midpoint of upper margin of jugular foramen (corresponds to highest point of jugular bulb) to the level of lower margin of internal auditory canal, PAIVe: Opening of vestibular aqueduct to lateral edge of internal auditory canal.).

Morphological classification

PAI classification was revised depending on Unur *et al*. (2007).

Type 1: Round
Type 2: Oval
Type 3: U- shape
Type 4: Fissura
Type 5: Irregular
Type 6: V-shape (Fig. 3).

Statistical Analysis. SPSS 21 software program was used to calculate minimum (min.), maximum (max.), mean and standard deviation from morphometric measurements. Measurements of the right and left sides of the cranium were compared using Student's t-test and any significant difference was revealed using Pearson's correlation test.

RESULTS

Morphometric measurements of the PAI on the temporal bone were classified under three groups including the distances to adjacent formations, shape and morphology of the orifice. The mean, min., max. and standard deviation (sd) values of all parameters measured were determined (Table I).

The mean vertical length of the PAI was measured as 4.12±1.01 mm on the right and 4.54 ± 0.88 mm on the left. The mean horizontal length of the right PAI was 6.83 ± 1.59 mm, and the mean horizontal length of the left PAI was 6.31 ± 1.47 mm. The distance between the PAI and the sigmoid sinus groove was measured as 19.64 ± 2.6 mm on the right and 21.06 ± 2.81 mm on the left. Measurement results of the PAIV, PAIH and PAIS on the right and left sides were compared using Student's t-test. A significant difference was found between the right and left sides ($p<0.05$); however, the difference between other measurements was not significant ($p>0.05$; Table I).

On the left side, a strong positive correlation was found between the PAIU and PAIA (r=0.534; p=0.000) and between the PAIH and PAIV (r=0.383; p=0.000; Table III).

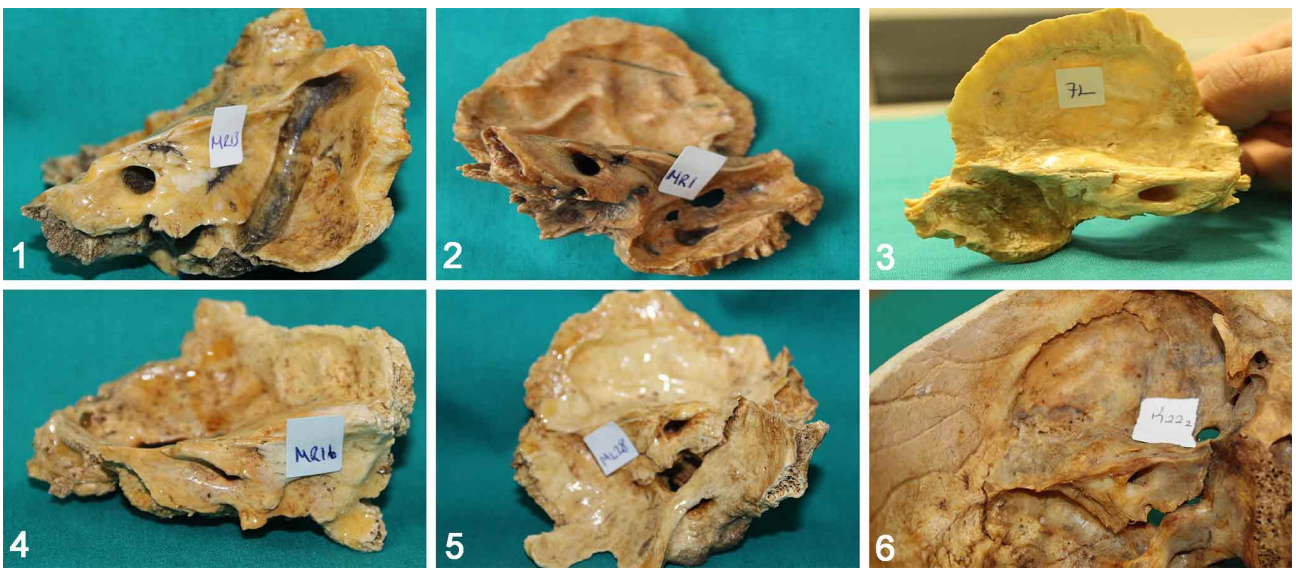

Fig. 3. Different forms of expansion of internal acoustic opening (1: Round, 2: Oval, 3: 'U' shape, 4: Fissure, 5: Irregular, 6: "V" shape).

On the right side, a strong positive correlation was found between the PAIU and PAIA (r=0.350; p=0.001) and between the PAIAp and PAIA (r=-0.349; p=.0001; Tables II and III).

The most common type of PAI on all the temporal bones was a round shape in 62 (37.3 %) bones, followed by an oval shape in 57 (34.3 %) bones. The most common right and left PAI shape was round (32.5 % and 42.2 %, respectively). The least common type, the V-shape was detected in 2.4% of all subjects; 1.2 % on the right and 3.6 % on the left (Fig. 2; Table IV).

The reference interval for the PAIH and PAIV was determined using least squares regression analysis.

The resulting regression equations
*Right PAIH (mm) = 3.719 + PAIH x 0.59
*Left PAIH (mm) = 3.096 + PAIH x 0.230

DISCUSSION

It is important to evaluate the (IAM) morphometrically to create an anatomical basis for intracranial pathology such as microsurgery of the cerebellopontine angle and acoustic neuroma. In addition, knowledge of normal values and IAM anatomy is vital in determining temporal bone trauma, congenital anomalies, individual nerves and ear diseases that require surgery. As an indicator of diseases, such as tumours or internal auditory stenosis, it is important to know the measurements of both sides of the IAM. Furthermore, there are some differences in the IAM's morphometric data due to different races and regions, and it also varies between the right and left sides (Farahani *et al*., 2007; Polat *et al*., 2019).

A retromastoid approach is usually preferred in surgical procedures on vestibular schwannomas. The largest

Table I. Mean values, standard deviations and minumum-maximum values of parameters belonging to internal acoustic porus (in mm).

	Right Temporal Bone				Left Temporal Bone				
Parameters	n	Min.	Max.	Mean±SD	n	Min.	Max.	Mean±SD	p
PAIV	83	2.12	7.92	4.12±1.01	83	1.84	6.70	4.54±0.88	0.005
PAIH	83	3.98	11.18	6.83±1.59	83	3.17	10.34	6.31±1.47	0.029
PAIU	83	2.86	8.08	5.04±1.28	83	1.95	9.17	4.81±1.1	0.229
PAIA	83	3.26	9.38	6.15±1.37	83	2.77	10.24	6.19±1.55	0.843
PAIAp	83	11.18	26.15	18.47±3.63	83	14.54	31.73	19.01±2.96	0.303
PAIVe	83	4.78	19.66	11.22±2.23	83	4.75	90.82	13.19±8.96	0.054
PAIS	83	10.48	26.17	19.64±2.6	83	13.44	27.09	21.06±2.81	0.001

(SD: Standard deviation, PAIV: Vertical diameters of internal auditory canal, PAIH: Horizontal diameters of internal auditory canal, PAIS: From the uppermost point on anterior wall of sigmoid sulcus to lateral wall of internal auditory canal, PAIU: Mid point of upper margin of internal auditory canal to superior border of petrous bone, PAIA: Midpoint of upper margin of jugular foramen (corresponds to highest point of jugular bulb) to the level of lower margin of internal auditory canal, PAIVe: Opening of vestibular aqueduct to lateral edge of internal auditory canal.

Table II. Pearson correlation coefficient between parameters belonging to right internal acoustic opening.

		PAIV	PAIH	PAIU	PAIA	PAIAp	PAIVe	PAIS
PAIS	r	0.119	0.109	-0.015	0.032	0.048	-0.030	1
	p	0.285	0.328	0.890	0.777	0.667	0.789	
PAIVe	r	-0.091	-0.013	0.173	0.139	-0.075	1	
	p	0.414	0.910	0.117	0.209	0.500		
PAIAp	r	0.276*	0.051	-0.111	-0.349**	1		
	p	0.011	0.646	0.317	0.001			
PAIA	r	-0.072	-0.093	0.350**	1			
	p	0.520	0.403	0.001				
PAIU	r	-0.192	0.076	1				
	p	0.083	0.494					
PAIH	r	0.093	1					
	p	0.404						
PAIV	r	1						
	p							

(*:Correlation is significant at the 0.05 level (2-tailed), **:Correlation is significant at the 0.01 level (2-tailed), PAIV: Vertical diameters of internal auditory canal, PAIH: Horizontal diameters of internal auditory canal, PAIS: From the uppermost point on anterior wall of sigmoid sulcus to lateral wall of internal auditory canal, PAIU: Mid point of upper margin of internal auditory canal to superior border of petrous bone, PAIA: Midpoint of upper margin of jugular foramen (corresponds to highest point of jugular bulb) to the level of lower margin of internal auditory canal, PAIVe: Opening of vestibular aqueduct to lateral edge of internal auditory canal.

Table III. Pearson correlation coefficient between parameters belonging to left internal acoustic opening.

		PAIV	PAIH	PAIU	PAIA	PAIAp	PAIVe	PAIS
PAIS	r	-0.108	-0.036	0.083	0.060	0.180	-0.013	1
	p	0.331	0.744	0.454	0.589	0.104	0.911	
PAIVe	r	-0.055	0.173	0.077	0.111	0.098	1	
	p	0.624	0.117	0.488	0.316	0.376		
PAIAp	r	0.139	0.192	0.002	-0.068	1		
	p	0.212	0.082	0.983	0.542			
PAIA	r	-0.091	-0.240*	0.534**	1			
	p	0.412	0.029	0.000				
PAIU	r	-0.016	-0.113	1				
	p	0.884	0.309					
PAIH	r	0.383**	1					
	p	0.000						
PAIV	r	1						
	p							

(*: Correlation is significant at the 0.05 level (2-tailed), **.Correlation is significant at the 0.01 level (2-tailed), PAIV: Vertical diameters of internal auditory canal, PAIH: Horizontal diameters of internal auditory canal, PAIS: From the uppermost point on anterior wall of sigmoid sulcus to lateral wall of internal auditory canal, PAIU: Mid point of upper margin of internal auditory canal to superior border of petrous bone, PAIA: Midpoint of upper margin of jugular foramen (corresponds to highest point of jugular bulb) to the level of lower margin of internal auditory canal, PAIVe: Opening of vestibular aqueduct to lateral edge of internal auditory canal.).

Table IV. Distribution of different forms of expansion of internal acoustic opening (n: number ,%).

	Total		Rigth		Left	
	n	%	n	%	n	%
Round	62	37.3	27	32.5	35	42.2
Oval	57	34.3	31	37.3	26	31.3
'U' Shape	11	6.6	6	7.2	5	6.0
Fissura	11	6.6	6	7.2	5	6.0
Irregular	21	12.7	12	14.5	9	10.8
V Shape	4	2.4	1	1.2	3	3.6
Total	166		83		83	

anterior inferior cerebellar artery, as well as cranial nerves VII, IX and X, may be injured during procedures performed by a retrosigmoid approach. In the present study, the PAIA was 6.15 ± 1.37 mm (3.26 to 9.38 mm) on the right and 6.19 ± 1.55 mm (2.77 to 10.24 mm) on the left. A retrosigmoid approach requires the patient to be positioned slightly towards the lesion at a semi-sitting position and the bone should be incised upwards towards and lateral side in order for the sigmoid and transverse sigmoid sinus to be reached. A superficial sigmoid sinus approach is therefore safer to reach the PAI through a regression formula. The PAIS was Day *et al*. (1994) 34.5 mm, Bozbuga *et al*. (1998) 31.8 mm on the right and 31.3 mm on the left, and Özoçak *et al*. (2014) 18.0 mm. The PAIS on the anterior wall was 19.64 ± 2.6 mm on the left and 21.06 ± 2.81 mm on the right. The difference between the right and left PAIS measurements was statistically significant, and although the measurements were smaller than those detected by Bozbuga *et al*. (1998), they were consistent with the study conducted by Özoçak *et al*.(2014). Kolagi *et al*.(2010) found the PAIS to be 38.94 ± 2.34 mm on the right side and 38.09 ± 2.38 mm on the left side. In our study, we found that these distances were found to be larger than our measurements for PAIS, which is likely because Kolagi *et al*. (2010) measured the distance of the sigmoid sinus groove from the posterior wall.

There are different studies related to the PAI that are very important for surgical procedures. Olivares *et al*. (1979) reported in their study that a narrow PAI may cause hearing loss and dizziness. Furthermore, Olivares *et al*. (1979) reported PAIV and PAIH in their histological study conducted on 144 patients with mild hearing loss to be 3.68 mm (2.10 to 5.26 mm) and 3.72 mm (2 to 5.8 mm), respectively. Some researchers detected the PAIV on dry bone to be 4.14 mm numbers 4.5 mm (Table V), whereas the mean PAIV detected in the present study varied between 4.11 mm and 4.54 mm (Tables I and V). The PAIH was found to be 3.2 to 5 mm by 11 to 14.6 mm by Cokkeser *et al*. (2001), and 5.8 to 15.1 mm by Özocak *et al*. (2014). They reported the shortest PAVe as 3.9 ± 0.8 mm. The superior margin of the petrous part includes important anatomic formations, such as the connection site of the superior petrous sinus and the posterior margin of the tentorial lamina. Gupta & Gupta (2009) found the distance to be 4 mm in 90 % of the samples for surgical procedures; in the present study, we detected that 77 % of our samples had measurements longer than 4 mm: 5.28 ± 6 on the right, 5.11 ± 6 mm on the left, with a mean of 5.11 ± 6 mm.

We measured the distance to be 5.04 ± 1.28 mm on the left side and 4.81 ± 1.1 mm on the right side. Such distances may allow the surgeon to remove tumours located

Table V. Various measurements of the formation of the temporal bone showing according to the researchers.

Authors	Population	Sample		PAIV	PAIH	PAIS	PAIVe	PAIU	PAIA	PAIAp
Unur *et al*., 2007.	Turkey	50 dry skulls	R	4.5±1	6.8±1.8			4.5±1	6.1±1.9	16.2±2.1
			L	4.5±0.7	6.6±1.9			4.4±0.9	6.6±1.8	16.3±2.1
Özocak *et al*., 2014.	Turkey	67 dry temporal .	R			7.5±1.4	9.8±0.8	7.4±1.6		
			L	4.3±0.7	9.8±2.0	7.6±1.3	9.8±0.9	7.9±1.4	3.9±0.8	22.3±3.1
Kobayashi *et al*., 1987.	Iran	14 dry temporal bones	T	4.11±0.6	5.04±1.04					
Kolagi *et al*., 2010.	India	224 dry temporal	R	4.18±0.84	6.5±1.15	38.94±2.34	10.44±1.82	5.56±0.95	6.29±1.11	
			L	4.14±0.94	6.44±0.94	38.09±2.38	10.35±1.43	5.79±0.99	6.14±1.08	
Erkoç *et al*., 2012.	Turkey	3786 MR	M	5.93 ± 0.24	5.71 ± 0.24					
			F	5.87 ± 0.25	5.68 ± 0.25					
In our study	Turkey	168 dry temporal	R	4.12±1.01	6.83±1.59	19.64±2.6	11.22±2.23	5.04±1.28	6.15±1.37	18.47±3.63
			L	4.54±0.88	6.31±1.47	21.06±2.81	13.19±8.96	4.81±1.1	6.19±1.55	19.01±2.96

(PAIV: Vertical diameters of internal auditory canal, PAIH: Horizontal diameters of internal auditory canal, PAIS: From the uppermost point on anterior wall of sigmoid sulcus to lateral wall of internal auditory canal, PAIU: Mid point of upper margin of internal auditory canal to superior border of petrous bone, PAIA: Midpoint of upper margin of jugular foramen (corresponds to highest point of jugular bulb) to the level of lower margin of internal auditory canal, PAIVe: Opening of vestibular aqueduct to lateral edge of internal auditory canal).

at this site by removing the bone on the upper edge of the PAI without causing damage to any important anatomic formations. Bozbuga *et al*. (1998) and Özocak *et al*. (2014) reported the PAIVe to be 8.00 to 22.00 mm and 8.5 to 11.00 mm, respectively, with a mean of 9.86 ± 6.1 on the right and 9.91 on the left. In the present study, the distance to the PAIVe varied between 4.78 and 19.66 mm on the right with a mean of 11.22 ± 2.23 mm, and between 4.75 and 9.82 mm on the left with a mean of 13.19 ± 8.96 mm.

The PAIAp was measured as 14.5 to 27.7 mm with a mean of 22.3 ± 3.1 mm by Özocak *et al*. (2014). In the present study, the PAIAp varied between 11.18 and 26.15 mm on the right with a mean of 18.47 ± 3.63 mm, and between 14.54 and 31.73 mm on the left with a mean of 19.01 ± 2.96 mm Özocak *et al*. (2014) measured the PAIAp to belonger. Recognition of the distance to the PAIAp is important in detecting the distance to the trigeminal ganglion.

Farahani *et al*. (2007) the mean of the PAI width was 4.11 ± 0.631 mm (ranged between 3 and 6 mm). In Brazilian adults, the PAI anterio-posterior width was 4.47 mm, and in children it was 4.82 mm. In Turkey, the mean PAI diameters did not show any significant difference between male and female skulls, with means of 5.93 ± 0.24 mm and 5.87 ± 0.25 mm, respectively Erkoç *et al*. (2012). Also, Erkoç *et al*. (2012) found no significant difference in IAM width between sex or age groups. In Egypt, the same parameter was found to be 5.44 ± 1.02 mm in control group; 5.27 ± 0.68 mm in a normal group; 11.61 ± 1.31 mm in Patulous; and 1.43 ± 0.54 mm in a stenotic group. In this study, the means of IAM width were 6.83 ± 1.59 mm and 6.31 ± 1.47 mm on the right and left side, respectively. Among these studies, the value closest to our study is the study conducted by Erkoç *et al*. (2012) .We found significant differences between the IAM width values of Iranians, Brazilians and Egyptians with our population; having lower values than the Egyptian Patulous group. From this data, our results are more similar to the healthy Turkish group. We think that the reason for the difference between the studies may be due to the difference in origin.

We measured the PAIH to be 3.98 to 11.18 mm on the right, with a mean of 6.83 ± 1.59 mm, and 3.17 to 10.34 mm on the left, with a mean of 6.31±1.47mm (Table I). Erkoç *et al*. (2012) study conducted on MRI images of 3786 individuals, the measurement called "antero-posterior (AP)" corresponds to the PAIV measurement in the present study. They evaluated AP measurements on 4 age groups, and the closest value detected in the present study was found to be in the age group of 41 to 50 years. The value identified as "cranio-caudal (CC)" appears to be similar to the PAIH measurement in the present study. The PAIH measurement values of the present study are closer to the values detected in the age group of Erkoç *et al*. (2012).

Farahani *et al*. (2007) performed with Iranian cadavers, the mean of the PAIV was found to be 5.04±1.04 mm. Sakashita & Sando (1995) reported the same dimension as 4.8±1 mm. Polat *et al*. (2019), the means of the IAM's vertical distance were 4.65 mm and 4.66 mm in the right and left side of females, respectively. The same measurements were 5.13 mm and 5.13 mm in the right and left side of males, respectively. In the present study, the means of the IAM's horizontal distance were 4.12±1.01 mm and 4.54 ± 0.88 mm in the right and left side, respectively. We found significant differences between the IAM average influence values of Iranian, Japanese and Turks and our population. This study was smaller than other data.

Marques *et al*. (2012) performed in Brazil, the mean PAIVe according to CT images were found to be 11.88 mm in children and 11.35 mm in adults. Mutlu *et al*. (1997), the PAIVe was found to be 10.98 ± 1.57 mm, and the difference between the right and left measurements was not statistically significant. In our study, the difference of 11.22 ± 2.23 mm on the right side and 13.19 ± 8.96 mm on the left side was not statistically significant.

There are many studies that have been conducted on dry skulls, radiography images, dissected temporal bones or CT images, and on IAM morphometry or volume using MRI (Farahani *et al*., 2007; Özocak *et al*., 2014; Erkoç *et al*., 2012; Mutlu 1997). However, there are few studies regarding gender and age (Erkoç *et al*., 2012; Papangelou 1975, Kobayashi & Zusho, 1987; Matsuanaga *et al*.,1991). The relation of the dimensions and shape of the normal internal auditory canal in regards to age and sex were statistically investigated on 242 paired human ears; however, no correlation was found between shape, age and sex. In our study, the difference between right and left PAIV, PAIH and PAIS measurements was statistically significant. There are very few similar studies in the literature to compare with this data. Erkoç *et al*. (2012) did not compare the right and left measurements of individuals in their study of 3786 patients using MRI images. Valvassori & Palacios (1998) reported that the right and left IAC diameters were almost symmetrical; in 99 % of patients, the difference was 1 mm, and in the other 1%, it was 1 to 2 mm. Kolagi *et al*. (2010) reported that the vertical diameter may vary between 3 to 7 mm in their studies on dry temporal bone. There was no statistical difference in both Valvassori & Palacios (1998) and Kolagi *et al*. (2010) However, in our study, the difference between the right and left PAIV and PAIH measurements was statistically significant.

Many researchers reported that unilateral or bilateral narrower PAI may cause hearing loss. Amjad at al. (1969), Lo (1998), Ito *et al*. (2005), Unur *et al*. (2007), Erkoç *et al*. (2012) by classified the shapes under 5 types and detected round shape as the most common type (Amjad *et al*., 1969; Lo, 1998; Ito & Sayaka, 2005; Unur *et al*., 2007; Erkoç, 2012. The PAI shapes from most common shape to the least common were detected as round, oval, U-shape, fissure, irregular and V-shape which was not identified by any researcher before. In addition, in our study, we defined the PAI opening hole as V. As seen in the figure 3, we have defined a different type in this way due to the fact that it is very different from the U-shape and the mouth part is narrowed and the structures passing through it (nerve, artery and vein) can get stuck in that area. The difference of the measurements provided in previous studies may depend on the race, age, gender and skull size. The similarity of the measurements obtained by Unur *et al*. (2007) and by the present study may be caused by examination of bone collection provided from same region (Table IV). Additionally, this study presents normative data of the IAM in a dry human Turkish population.

CONCLUSION

We believe that having knowledge on morphometric shape and morphological measurements of the PAI may help during surgical procedures involving the PAI and posterior cranial fossa. Since the formations passing inside the PAI and the proximity of the pontocerebrallar edge make this site clinically important, we consider that the recognition of morphology and morphometry of the PAI would allow the surgeon access without injuring any anatomic formations on the site during surgical procedures of the inner ear. This study provides baseline information that may be used to evaluate the congenital anomalies of the PAI.

Furthermore, PAIV was measured as 4.12±1.01 mm on the right and 4.54 ± 0.88 mm on the left; PAIH was measured as 6.83 ± 1.59 mm on the right and 6.31 ± 1.47mm on the left; and PAIS was measured as 19.64 ± 2.6 mm on the right and 21.06 ± 2.81 mm on the left. The difference between right and left PAIV, PAIH and PAIS measurements was statistically significant. By giving formulas, if one length is known, the other length can be estimated:

*Right PAIH (mm) = 3.719 + PAIH x 0.59
*Left PAIH(mm) = 3.096 + PAIH x 0.230

We believe that the present study would make a contribution to the dry bone data of our community.

AKIN SAYGIN, D.; NUR TÜRKOGLU, F.; AYDIN KABAKÇI, A. D. & ALPA, S. Poro acústico interno: Diferentes hitos óseos y sus implicaciones clínicas. *Int. J. Morphol., 40(5)*:1368-1375, 2022.

RESUMEN: El poro acústico interno es un espacio que se abre en la cara posterior de la parte petrosa del hueso temporal, donde entran los nervios facial, intermedio y vestibulococlear, además de la arteria laberíntica. El propósito de este estudio fue la evaluación del poro acústico interno desde una perspectiva morfométrica, determinación de la forma del foramen y de la distancia a algunas formaciones anatómicas importantes. Este estudio se realizó en 166 huesos temporales de individuos de sexo desconocido que forman parte de la colección de cráneos del Departamento de Anatomía en NEU y KTO, Universidad de Karatay, Se midió la altura vertical y el diámetro del poro acústico interno, su distancia a los lados inferior y superior de la superficie posterior de la parte petrosa, su distancia al surco del seno sagital superior y su distancia al vértice. Además, el poro acústico interno se clasificó en seis grupos: redondos, ovalados, en forma de U, de fisura, irregulares y en forma de V. Se utilizó un calibrador digital para las mediciones del meato acústico interno. Mientras que los diámetros horizontales, verticales y la distancia al surco para el seno sagital superior del poro acústico interno en el lado derecho fue de 4,12 mm, 6,83 mm y 19,64 mm respectivamente, en el lado izquiedo fue de 4,56 mm, 7,10 mm y 21,06 mm, respectivamente. Hemos observado que en el 37,3 % de los casos el poro acústico interno era redondo, el 34,3 % ovalado, el 6,6 % en forma de U, el 6,6 % de fisura, el 12,7 % irregular y el 2,4 % en forma de V. Estas medidas pueden servir de guía y ayuda en los procedimientos quirúrgicos

PALABRAS CLAVE: Cráneo; Poro acústico interno; Hueso temporal; Surco para el seno sagital superior.

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