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INTERNAL ACOUSTIC MEATUS: A MORPHOMETRIC STUDY ON DRY SKULL

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ABSTRACT :

INTRODUCTION- One of the most significant canals that connects or passes through the internal ear of the skull and the posterior cranial fossa is the internal acoustic meatus (IAM). The labyrinth blood vessels and the two significant cranial nerves—the facial and vestibulocochlear nerves (7th and 8th)—pass via this canal (internal acoustic meatus.) The anatomical and functional characteristics of the IAC have been studied in a number of clinical and experimental investigations. To help surgeons prepare for pre-operative procedures, etc., **AIM AND OBJECTIVES -** The present study was planned to study the morphometric parameters of internal acoustic meatus by using Image-J application. Following parameter was measured in this study: - Lateral wall length of IMA bilaterally, Superior wall length of IMA bilaterally and Inferior wall length of IMA bilaterally. **MATERIALS AND METHODS-** The present descriptive cross-sectional study was carried at Department Anatomy, Index Medical Hospital and Research Centre, Indore (MP), India, from November 2021 to March 2024. The dried temporal bones of human skulls were randomly selected, and the age, sex and race of the temporal bone were not known. Study Material: Clean and dry temporal bone was used for the study. Study Design: Descriptive cross-sectional study. Sample Size: A total 100 Temporal bone, (50 right, 50 left). **Statistical analysis** – The data was represented in Mean±SD. The data was further compared using Unpaired t-test. Paired t-test was used to compare within the same parameters. Further, pearson correlation was done between the two variables.

RESULT- The lateral part of IAM in both the sides (right and left) was compared the right lateral part was 4.09 ±0.48 and left lateral part was 4.39 ± 0.37 and the difference was statistically significant. (p-value, 0.0007). The range of the right side was 2.82-5.04 and the left side was 3.56-5.91. The length of the superior wall of IAM in both the sides (right and left) was compared the right superior wall was 11.05 ± 1.43 and left superior wall was 10.88 ± 1.60 and the difference was statistically non-significant. (p-value, 0.59). The range of the right side was 8.76-15.15 and the left side was 8.37-14.72. The length of the inferior wall of IAM in both the sides (right and left) was compared the right inferior wall was 11.39 ± 1.07 and left inferior wall was 11.84 ± 1.23 and the difference was statistically significant. (p-value, 0.04). The range of the right side was 9.56-14.51and the left side was 9.89-14.58. **CONCLUSION-** The findings obtained was compared with the studies done by various authors showed that there is a difference in the obtained data among authors which emphasized on the fact that there will be racial and population differences, thus thrusting on the fact to have thorough knowledge on the values of various parameters of IAM among different population as this is one common site of surgical importance with important cranial nerves emerging out. Further, it will also help the otologist and clinician to have better management in issues regarding to IAM.

Introduction :

The internal acoustic canal (IAC), also known as the internal auditory canal or meatus (IAM), is a bony canal within the petrous portion of the temporal bone that transmits nerves and vessels from the posterior cranial fossa to the auditory and vestibular apparatus. The VII and VIII cranial nerves namely facial nerve and vestibulocochlear nerve and labyrinth vessels pass through the internal acoustic meatus (1). The IAC is closed laterally by a thin and perforated sheet of bone that separates it from the inner ear. It is through this plane that the blood vessels, the facial nerve and the vestibulocochlear nerve pass. This nerve divides into two near the lateral extremity of the internal acoustic meatus, forming the cochlear nerve and the vestibular nerve (2-4). The location of the internal acoustic meatus and identification and location of its anatomical landmarks minimizes the chance of injury to the facial nerve and provides an insight for the surgeons to rationalize the surgical approach in an ear surgery (5).

Identification of the facial nerve is very essential as injury to facial nerve is a dreadful complication of ear surgery and its outcome can be most devastating to the patient as well as the surgeon. Surgical intervention in acoustic neurinomas, cholesteotomas, preservation of cochlear nerve and inner ear is an ardous task and requires dedication to prevent an unfortunate disaster. Any form of damage to the vestibule, labyrinth or cochlear can cause leakage of endolymph leading to deafness if the tumors of the cochlear nerve are dissected in a traumatic way. (5).

It is essential to know the temporal bone well since it is very complex. Each one of its structures develops differently and they are all very close to each other. According to the literature, the IAC is accessed via the middle cranial fossa. The IAC is a narrow canal that extends for roughly 1cm within the petrous part of the temporal bone and has the shape of an oval foramen. (6-8)

Many clinical and experimental studies have been done to analyze the anatomical and functional aspects of the IAC in human beings; however, with the advance of new diagnostic techniques in the area of otology, studies of the human temporal bone are being redone to provide better anatomical knowledge for surgeons, since there are great interindividual variability and structural variations that may occur regarding the other adjacent structures. (9-11)
Thus, the present study was aimed to study the morphometric measurements (lateral, superior and inferior wall) of IAM.

Materials and Methods

The present descriptive cross-sectional study was carried at Department Anatomy, Index Medical Hospital and Research Centre, Indore (MP), India, from November 2021 to March 2024. The dried temporal bones of human skulls were randomly selected and the age, sex and race of the temporal bone were not known. The study was approved by Institutional Ethics Committee.

Study Material: Clean and dry temporal bone was used for the study.

Study Design: Descriptive cross-sectional study.

Sample Size: A total 100 Temporal bone, (50 right, 50 left).

Sample size was estimated using software Power analysis and sample size, version 8 (PASS-2008).

Inclusion Criteria:

- Left and right both side dry temporal bone without any break.
- Clean, dry temporal bone was included in the study.

Exclusion Criteria:

- Bone with any sign of fracture and deformities was excluded from the study.

Study Tools:

Following instruments was used in the study-

Injecting Gun for Filling of the silicone in internal acoustic meatus

Fixator silicone gel

A caulking machine has a cartridge or tube which contains silicone that can be triggered and deposited into areas where there is a gap or space. A silicone gel sheet is a soft, flexible, self-adhesive dressing**.**
They are of two types-
Condensation Silicone – Supplied as a two paste / putty system. It has a good detail reproduction
Addition silicons – It has High dimensional stability, Excellent flow properties and good detail reproduction. It is expensive and has short shelf life.

Procedure Methodology

The impression of the internal acoustic meatus was taken by injecting the silicone material into the internal acoustic meatus. After injecting the material its leave 16-20 hours to harden inside the internal acoustic meatus and then taken out from internal acoustic meatus.
All the samples were photo graphed with high resolution camera with same distances. Above mentioned parameters of the IAM were calculated and measured with the help of ***Image J Software***.
Image J is fast, reliable and most widely used image processing software as it is free open-source program, making it low cost and dependable tool for researchers. Application is developed by National Institute of Health Sciences (GOI). ImageJ is a Java-based image processing program developed at the National Institutes of Health and the Laboratory for Optical and Computational Instrumentation (LOCI, University of Wisconsin).
Statistical analysis – The data was represented in Mean±SD. The data was further compared using Unpaired t-test. Paired t-test was used to compare within the same parameters. Further, pearson correlation was done between the two variables.

Results :

Table – 1 Comparison between the right and left side of (Anterior, Posterior and Medial) part of IAM-

Parameters	Range	Mean±SD	P-value
Lateral wall of length			
Right	2.82-5.04	4.09±0.48	0.0007
Left	3.56-5.91	4.39±0.37	
Superior wall of length			
Right	8.76-15.15	11.05±1.43	0.594
Left	8.66-14.15	10.88±1.60	
Inferior part of length			
Right	9.56-14.51	11.39±1.07	0.046
Left	9.89-14.58	11.84±1.23	

* Correlation is significant at the 0.05 level (2-tailed)

Table – 2 Paired Sample t-test for the length of wall of IAM.

Paired t-test Statistics			
	Mean±SD	**Std Error**	**P-value**
Lateral part of length (Right-Left)	0.304±0.67	0.087	0.001*
Superior wall length (Right-Left)	0.161±1.93	0.274	0.558
Posterior wall of length (Right-Left)	0.448±1.38	0.195	0.026*

* Correlation is significant at the 0.05 level (2-tailed)

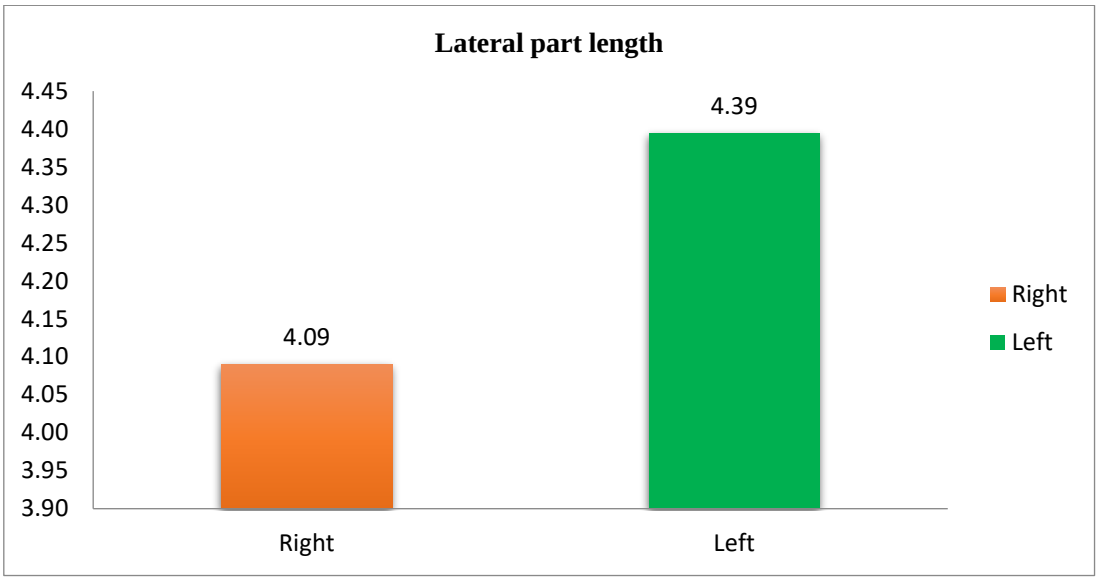

Figure – 4 Bar Graph represents the Right and left side length of lateral part of IAM

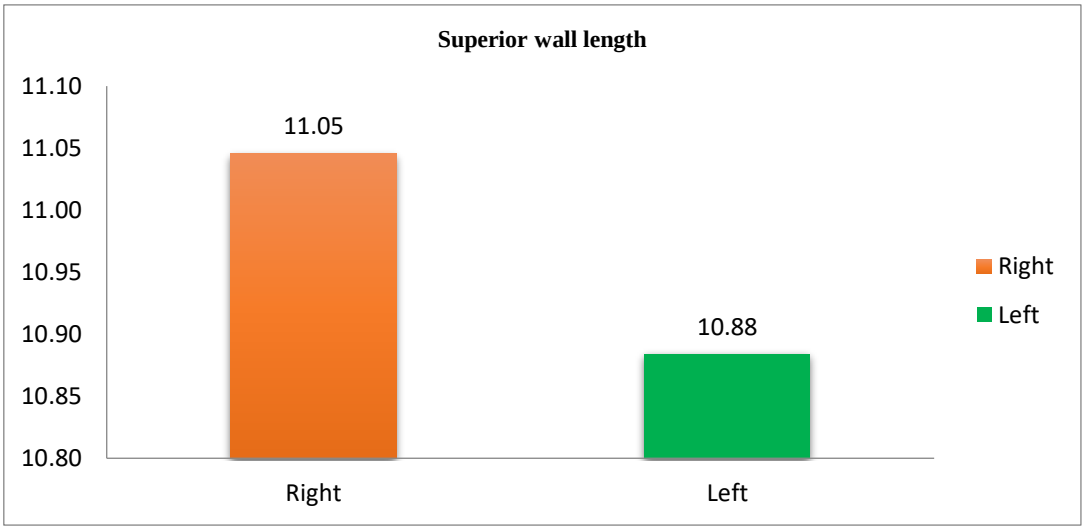

Figure – 4 Bar Graph represents the Right and left side length of Superior wall of IAM

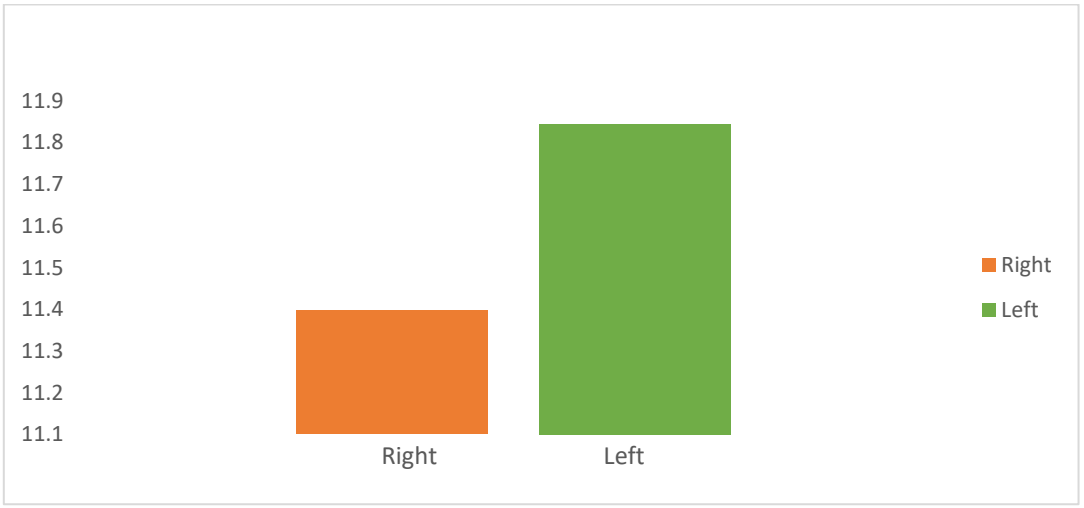

Figure – 4 Bar Graph represents the Right and left side length of Inferior wall of IAM

Table – 3 Pearson correlation between the parameters of Right side of IAM.

Parameters	LW	SW	IW
LW	1	.004	-.090
SW	-	1	.545**
IW	-	-	1

** Correlation is significant at the 0.01level (2-tailed)
Wall Of Internal Acoustic Meatus. LW – Lateral wall, SW – Superior wall, IW – Inferior wall.

Table – 4 Pearson correlation between the parameters of Left side of IAM.

Parameters	LW	SW	IW
LW	1	.295*	.243
SW	-	-	.270
IW	-	-	1

** Correlation is significant at the 0.01level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)
Wall Of Internal Acoustic Meatus. LW – Lateral wall, SW – Superior wall, IW – Inferior wall.

- The data is represented in tables and figures.
- The data includes mean and SD of right and left side of anterior, posterior, medial, lateral, superior, posterior wall of IAM.
- The unpaired and paired t-test was calculated to compare the mean of both side of IAM
- Further, Pearson correlation was carried out between the variables of right and left side respectively.
- The lateral part of IAM in both the sides (right and left) was compared the right lateral part was 4.09 ±0.48 and left lateral part was 4.39 ± 0.37 and the difference was statistically significant. (p-value, 0.0007). The range of the right side was 2.82-5.04 and the left side was 3.56-5.91. Further paired statistics showed that right and left lateral part had 0.304 ± 0.61 and it was statistically significant. (p-value, 0.001). (Table- 1 , 2; figure- 1)
- The length of the superior wall of IAM in both the sides (right and left) was compared the right superior wall was 11.05 ± 1.43 and left superior wall was 10.88 ± 1.60 and the difference was statistically non-significant. (p-value, 0.59). The range of the right side was 8.76-15.15 and the left side was 8.37-14.72. Further paired statistics showed that right and left length of superior wall had 0.161±1.93 and it was statistically non-significant. (p-value, 0.558). (Table 1,2 ; figure-2)
- The length of the inferior wall of IAM in both the sides (right and left) was compared the right inferior wall was 11.39 ± 1.07 and left inferior wall was 11.84 ± 1.23 and the difference was statistically significant. (p-value, 0.04). The range of the right side was 9.56-14.51and the left side was 9.89-14.58. Further paired statistics showed that right and left length of inferior wall had .448±1.36 and it was statistically significant. (p-value, 0.02). (Table- 1,2; figure -3)

Discussion :

The internal acoustic meatus (IAM) is also known as the internal auditory canal (IAC). The two important cranial nerves namely the facial nerve and the vestibulocochlear nerve (7^{th} and 8^{th}) and the labyrinth blood vessels pass through this canal (internal acoustic meatus.) This canal has been clinically important as a region in which acoustic neuromas occur. (12) .Several clinical and experimental studies have been carried out to understand and analyze the anatomical and functional aspects of the IAC in the human body , however, with the advance of new diagnostic techniques in the area of otology, studies of the human temporal bone have become highly prevalent that may provide better anatomical knowledge in course of structure , location , associated nerves , vessels with (IAM) for surgeon for better clinical management, since there are greater inter-individual variability and structural variations. (13). The morphometric measurement of Internal acoustic canal is important to understand the structure of IAM and its passing structure from it. Thus, the present study was aimed to study the morphometric parameters (anterior, posterior, medial) of Internal acoustic meatus with the help of Image J Software. Furthermore, we studied the ***Length of the lateral part of the IAM is termed as*** the distance from the lateral margin of the foramen singular to the most lateral point of the fundus in the lamina cribrosa (LC) area for the IVN. In our present study when the length of the lateral part of IAM in both the sides (right and left) was compared the right lateral part was 4.09 ±0.48 mm and left lateral part was 4.39 ± 0.37 mm and the difference was statistically significant. (p-value, 0.0007). The range of the right side was 2.82-5.04 mm and the left side was 3.56-5.91 mm . Further paired statistics showed that right and left lateral part had 0.304 ± 0.61 mm and it was statistically significant. (p-value, 0.001). In a different study, Farahani R.M. et al.

(2012) measured the length of lateral section of the IAM, finding that it was 2.43±0.416 mm . (16). Further According to a study by Mamatha Y et al. (2018), the length in left side was 3.19 ±0.48 mm and 3.08 ± 0.45 mm on the right side. (15) One of the studies that included the anthropometry of IAM in addition to its three-dimensional structure was reported by Sakashita & Sando in their 1995 article, they concluded the length of medial wall was between 1.5 mm and 3.5 mm (2.7 ± 0.7) mm (15) these were in consistent with our present study. Moreover, we further estimated the ***Length of the superior wall of IAM*** which is defined as the distance from the superior margin of the porus to the most lateral point of the fundus in the lamina cribrosa (LC) area for the superior vestibular nerve (SVN). In our present study when the length of the superior wall of IAM in both the sides (right and left) was compared the right superior wall was 11.05 ± 1.43 mm and left superior wall was 10.88 ± 1.60 mm and the difference was statistically non-significant. (p-value, 0.59). The range of the right side was 8.76-15.15 mm and the left side was 8.37-14.72.mm Further paired statistics showed that right and left length of superior wall had 0.161±1.93 mm and it was statistically non- significant. (p-value, 0.558). In their 1995 work, Sakashita & Sando detailed the anthropometry of IAM. They measured the superior length of IAM and discovered 10.6 ± 2.2 mm and ranges from (6.9-14.1mm). (14) The mean superior length of the IAM in Indians was measured to be 9.89±1.04 mm on the right side and 9.94±0.98 mm on the left. In 2018, Mamatha Y. et al. (15).
In a different study, Farahani R.M. et al. (2012) measured the length of superior wall of the IAM, finding that it was 10.75±1.65 mm (16) these findings were in consistent with our present study.

Lastly, we estimated the ***Length of the inferior wall of IAM*** is termed as the distance from the inferior margin of the porus to the most lateral point of the fundus in the LC area for the inferior vestibular nerve (IVN)**.**
In our present study when the length of the inferior wall of IAM in both the sides (right and left) was compared the right inferior wall was 11.39 ± 1.07 mm and left inferior wall was 11.84 ± 1.23 mm and the difference was statistically significant. (p-value, 0.04). The range of the right side was 9.56-14.51mm and the left side was 9.89-14.58 mm.
Further paired statistics showed that right and left length of inferior wall had .448±1.36 and it was statistically significant. (p-value, 0.02).
According to research by Farahani, R. et al. (2012), the inferior wall of the IAM measured was 8.39±1.11mm. (16) In their 1995 work, Sakashita & Sando detailed the anthropometry of IAM. They measured the inferior length of IAM and discovered 9.6 ± 2.4mm and ranges from (4.5-13.7mm). (14) According to a different study by Mamatha Y et al. (2018), the inferior lengths of the IAM on the right and left sides were 8.43±1.33 mm and 8.59±0.9 mm, respectively. (15), these data were in same as our present study.

Moreover, at last we also carried out the pearson correlation between the variables of IAM in both Right and Left side, and we found significant correlation between different variables.
Thus, after studied all the length of wall we can conclude that there are variations in the dimensions by different studies with respect to our own study. The variations of dimensions may be attributed to the differences in race of the study population

Conclusion :

The present study was done to obtain the measurements of different parameters of IAM among temporal bone of adult dry skulls using an Image J software. The findings obtained was compared with the studies done by various authors showed that there is a difference in the obtained data among authors which emphasized on the fact that there will be racial and population differences, thus thrusting on the fact to have thorough knowledge on the values of various parameters of IAM among different population as this is one common site of surgical importance with important cranial nerves emerging out. Further, it will also help the otologist and clinician to have better management in issues regarding to IAM.

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