Section: Anatomy

Original Research Article

MORPHOMETRIC STUDY OF THE INTERNAL ACOUSTIC MEATUS DIMENSIONS AND CORRELATION USING BONE CASTS

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Received *: 25/09/2025*
Received in revised form *: 09/11/2025*
Accepted *: 29/11/2025*

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DOI: 10.70034/ijmedph.2025.4.380

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (4); 2124-2127

ABSTRACT

Background: The internal acoustic meatus was oval shaped short bony located on the posterior surface of the petrous portion of the temporal bone, provides a passage between the inner ear and the posterior cranial fossa. It carries the vestibulocochlear nerve, the motor and sensory roots of the facial nerve, the labyrinthine vessels, and the vestibular ganglion. A clear understanding of its anatomy and the relationships of these structures is essential for evaluating and managing conditions involving the internal acoustic meatus.

Materials and Methods: This study was carried out on 72 dry temporal bones (36 on right and 36 on left side) Department of Anatomy, Pacific Institute of Medical Sciences, Sai Tirupati University, Umarda, Udaipur, Rajasthan.

Results: The mean of width and height of fundus end of IAM on right side were 6.43 & 3.74 mm & 7.06 & 4.22 mm on left side respectively. The parameters between right and left sides by using independent t- test and it was found to be statistically significant.

Conclusion: The present study presents a baseline data on morphometric measurements of IAM of dry adult skulls among Rajasthan population, also confirms that there is a difference in dimensions of IAM among different races and regions and thus emphasises need to have knowledge of normal data of different population.

Keywords: Petrous temporal bone, Internal acoustic meatus, labyrinthine, Fundus.

INTRODUCTION

The internal acoustic meatus is a bony conduit within the petrous region of the temporal bone, positioned between the labyrinth and the posterior cranial fossa.[1] The internal acoustic meatus terminates laterally at the fundus, a vertical bony plate that separates it from the inner ear. The transverse (falciform) crest divides this vertical plate unevenly, and five nerves—the facial, nervus intermedius, cochlear, and the superior and inferior vestibular nerves—traverse separate openings positioned above and below the crest.[2] This canal is of clinical importance as it is a frequent site of acoustic neuromas. Quantitative and morphometric analysis of the internal auditory canal (IAC) is essential to provide the anatomical basis for microsurgical procedures in the cerebellopontine angle, since acoustic neuromas can induce bony changes and constitute a significant intracranial pathology. The internal auditory canal normally accommodates a neurovascular bundle about 2 mm in diameter, so any narrowing of this size or less is considered significant. Unilateral or bilateral enlargement of the IAC may occur due to tumors within the canal, such as acoustic neuromas, or, less commonly, advanced facial neuromas.[3] According to Rajanigandha Vadagaonkar et al., 2016, from Mangalore, the internal acoustic meatus (IAM) is a crucial landmark in neuro-otological procedures, including the removal of acoustic neuromas, repair of temporal bone fractures, and treatment of certain congenital anomalies. Familiarity with the anatomy of the IAM is important to avoid injury to adjacent vital structures such as the jugular bulb and saccus endolymphaticus. Due to their clear visibility and

firmness, bony landmarks offer greater reliability and suitability compared to soft-tissue markers.[4] Moffat et al. developed a classification system for acoustic neuromas based on their site of origin and morphological traits. MRI allows detailed visualization of the tumor's structure and its intracanalicular portion. These tumors arise along the vestibular nerve at the junction of peripheral and central myelin. Depending on the position of the neurilemmal–glial junction, the tumor may be located laterally within the internal auditory canal (IAC), at the porus acusticus, or medially in the cerebellopontine angle (CPA). On this basis, acoustic neuromas can be grouped into three distinct types. 1. Lateral neuromas (dumbbell-shaped): Tumors confined to the internal auditory canal (IAC) that often cause early hearing loss. 2 Medial neuromas (lollipop-shaped): Tumors arising in the cerebellopontine angle (CPA) which can enlarge considerably before noticeable hearing deficits appear. 3. Intermediate neuromas (cone-shaped): Tumors extending from the IAC laterally into the CPA medially, usually resulting in moderate auditory symptoms.[5] Suboccipital retrosigmoid craniotomy with removal of posterior wall of IAM is preferred by many surgeons operating on acoustic neuromas as the approach is simple and safe although the major drawback lies in exposing the IAM without damaging the inner ear endolymphatic spaces.[6,7] The shape of the internal auditory canal (IAC) transforms during development in response to cranial growth and achieves its final configuration in adulthood.[8] Many investigators have studied the IAM on radiographs, on casts, in dissected temporal bones and in histological section and have found that the dimensions, shape, and volume of the normal adult IAM vary widely, even between two sides of the same individual, as well as among different individuals. The aim of this study was to determine the morphometric parameters of the internal acoustic meatus and to assess the correlations between them. These data may also be useful for preoperative planning in patients undergoing surgery involving the internal acoustic canal.

MATERIALS AND METHODS

The present study included an examination of 72 (36 on right side and 36 on left side) dry temporal bones available in the Department of Anatomy Pacific Institute of Medical Sciences, Sai Tirupati University, Umarda, Udaipur Rajasthan. The study was conducted after obtaining approval from the Institutional Ethics Committee.

Inclusion Criteria

- Dry adult temporal non-fractured or non-damage bones

Exclusion Criteria

- Congenital or acquired anomalies and pathological defects.

Method

- 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 12-14 hours to harden inside the internal acoustic meatus and then taken out from internal acoustic meatus. Above mentioned parameters of the IAM were calculated and measured with the help of Digital Vernier Caliper.
- Width of the IAM at width of fundus on right side
- Width of the IAM at width of fundus on left side
- Height of the IAM at height of fundus on right side [Figure 1]
- Height of IAM at height of fundus on left side
- Correlation between width and height of fundus of IAM

Statistical analysis: Mean ± SD calculated for each parameter. Independent t-test applied for right-left comparisons. $P < 0.05$ considered statistically significant.

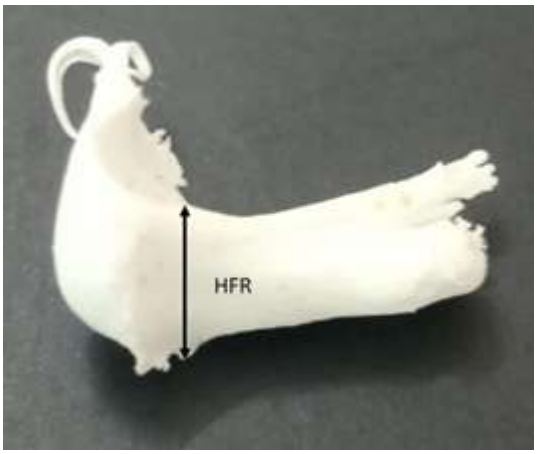

Figure 1: Height of fundus of IAM on right side

RESULTS

The mean height of fundus end on the right side was 3.74 ± 0.511 mm and the mean height of fundus on left side was 4.22 ± 0.545 mm. We found that the mean height of right side was significantly smaller than the left side, however, this variation is statistically significant ($t = -3.841$, $p = 0.000$). The p value is <0.0001. The result indicates clear asymmetry in height of fundus between right and left side of IAM [Table 1]. The width at the fundus of the IAM with the right-side measuring was 6.43 ± 1.40 and the left side measuring 7.06 ± 1.25 mm. The analysis showed positive significant difference in the width at the fundus end between the two side ($t = -2.029$, $p = 0.046$) [Table 1]. The correlation between right and left side of width at fundus was -0.170 whereas the correlation between right and left side of height was 0.180. The correlation coefficient of the left and right measurements of height shows weak positive correlation and the correlation coefficient of the left and right measurements of width was weak negative correlation. Both measurements are

independent of each other with no linear relationship [Table 2 & 3].

Table 1: Mean and standard deviation of width and height of fundus end

Parameter	Side	N	Mean±SD		Between group comparison in t-test
Width of fundus end	Right (WFR)	36	6.43	1.40	t value = -2.029
	Left (WFL)	36	7.06	1.25	p value= 0.046
Height of fundus end	Right (HFR)	36	3.74	0.511	t value =-3.841
	Left (HFL)	36	4.22	0.545	p value= 0.000

Table 2: Correlation between right and left side of width of fundus end

Parameter	Side	Correlation coefficient (r)	p value	Significant
Width of fundus end (WF)	Right	–0.170	0.322	Negative correlation
	Left			

Table 3: Correlation between right and left side of height of fundus end

Parameter	Side	Correlation coefficient (r)	p value	Significant
Height of fundus end (HF)	Right	0.180	0.293	Negative correlation
	Left			

DISCUSSION

There are many publications that describe how the shape, size and position of the human IAC can influence certain inner ear disorders. The IAC may serve as a canal for inner ear infection spreading that could damage it or reach the central auditory pathways.[9-11] Pretty et al,[12] (2017) on 37 temporal bones of dry adult skulls. They found that the mean and standard deviation height of fundus on the right side of internal acoustic meatus was 4.2±1.30 and left side was 3.5±1.01mm respectively. The mean of width of fundus end on right side and left side was 5.0±1.28 and 4.3±1.08 mm. Sakshita and Sando et al,[13] (1995) conducted a study on 20 temporal bones between 1 month to 72 years old and they found that the width of fundus end was 4.6 mm and 7.7 mm. Rajanigandha Vadagaonkar et al,[4] (2016) studied on 27 disarticulated, cadaveric dry temporal skulls and 35 dry skulls from Mangalore and they concluded that the mean width of IAM was 4.52. Abdulkadir Bilir et al. (2023),[14] conducted a study on 210 individuals. They found that the anterior posterior diameter was 6.3±1.5 mm. Marques et al,[15] (2012) conducted a detailed morphometric analysis of the internal auditory canal utilizing high-resolution computed tomography imaging on 110 subjects. They found that the opening width of IAM was 7.53 mm in children and 7.10 mm in adults. They also classified the shapes of IAM - cylindrical, funnel, bud shape. A study conducted by Kobayashi and Zusho (1987),[16] based on 300 IAC and they reported 4.5% funnel-shaped IAC, 72.7% cylindrical and 22.8% bud-shaped IAC. Mamatha et al (2019),[17] conducted a study on 40 adults of temporal bones of dry skulls. They found that the mean of width of fundus end was 3.08±0.45 on right side and 3.19±0.48 on left side and the mean of height of fundus on right side and left side was 3.26±0.50 & 3.36±0.48mm respectively. In the present study we found that the mean of fundus on right and left side was 3.74 and 4.22 mm. The left side of height of fundus is higher than right side. The measurement of width of fundus on right and left side was 6.43 and 7.06 mm. When we compare our study with other studies, we found that the values of height and width of fundus was slightly higher.

CONCLUSION

The morphometric analysis of the IAM shows that its dimensions are generally symmetrical between the right and left side but the height of fundus end is slightly lower than width of fundus end and statistically positive significant. These measurements help in the evaluation of various clinical conditions such as acoustic neuroma, stenosis, cochlear implantation and other pathologies.

REFERENCES

1. Bislare SG. Internal Auditory Meatus STEP BY STEP temporal bone dissection.1st edition. Jaypee Brother's medical publishers. New Delhi. 2014:56.
2. Stranding S. Gray's Anatomy. The anatomical basis of clinical practice. 41th Ed. New York: Elsevier Limited: 2016;643
3. Prashaanthi N, Krishnamoorthy K. Morphometric analysis of internal acoustic meatus. Res J Pharm Technol. 2016;9(10):1575–6.
4. Vadagaonkar R, Rai AR, Rai R, Prabhu LV, Pai MM, Vani PC. Morphometric analysis of internal acoustic meatus and its surgically relevant relations in human temporal bones. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2016 Sep 1;7(5):1584-8.
5. Moffat DA, Golledge J, Baguley DM, Hardy DG. Clinical correlates of acoustic neuroma morphology. J Laryngol Otol. 1993;107(4):290–4.
6. Ammirati M, Ma J, Cheatham ML, Maxwell D, Bloch J, Becker DP. Drilling the posterior wall of the petrous pyramid: a microsurgical anatomical study. J Neurosurg. 1993;78:452–5.
7. Blevins NH, Jackler RK. Exposure of the lateral extremity of the internal auditory canal through the retrosigmoid approach: a radioanatomic study. Otolaryngol Head Neck Surg. 1994;111:81–90
8. Mntungwa N, Human-Baron R, Hanekom T. Morphology of the internal auditory canal: deriving parameters from computer tomography scans—an observational STROBE MR study. Ear Nose Throat J. 2022;0(0):1–7.
9. Pellet W, Cannoni M, Pech A, Jacomy JP. Auto Neurosurgery. Ist ed. Germany: Springer; 1990.

10. Paparella MM, Shumrick DA, Gluckman JL, Meyerhoff WL. Otolaryngology: Basic Sciences and Related Principles. 3rd ed. Philadelphia: W.B. Saunders Co.; 1991.
11. Vilain J, Pigeolet Y, Casselman JW. Narrow and vacant internal auditory canal. Acta Otorhinolaryngol Belg. 1999;53(1):67–71
12. Pretty, R, KV Vinay, K Vishal, & N Beena. The morphometric study of internal acoustic meatus in dry skulls of South Indian adults. National Journal of Clinical Anatomy,2017; 6(1), 51–8.
13. Sakashita T, Sando I. Postnatal development of the internal auditory canal studied by computer-aided three-dimensional reconstruction and measurements. Ann Otol Rhinol Laryngol. 1995;104(6):469–75.
14. Bilir A, Fazlıoğulları Z, Tatar MC, Nayman A. Determination of morphometry and volume of the internal auditory canal. Kocatepe Med J. 2023;24(1):30–5.
15. Marques SR, Smith RL, Isotani S, Alonso LG, Anadao CA, Prates JC, et al. Morphological analysis of the vestibular aqueduct by computerized tomography images. Eur J Radiol. 2007;61(1):79-83.
16. Kobayashi H, Zusho H. Measurements of internal auditory meatus by polytomography. Br J Radiol. 1987;60:209-14
17. Mamatha Y, Trisha KR, Vishal Kumar. Anthropometry of internal acoustic meatus in dry adult human skulls using the casting method. Int J Anat Res. 2019;7(1.1):6113–8.