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Morphometric Analysis of Internal Acoustic Meatus and Its Surgically Relevant Relations in Human Temporal Bones.

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ABSTRACT

Internal acoustic meatus (IAM) is a chief landmark in various neuro-otological surgeries like removal of acoustic neuroma, temporal bone fractures and certain congenital anomalies. Understanding the anatomy of IAM is relevant during these surgeries to avoid injury to vital structures in its proximity like jugular bulb and saccus endolymphaticus. The aim of present study is to describe the morphometry of internal acoustic meatus with respect to the landmarks on postero-inferior surface of temporal bone and clivus. Twenty seven disarticulated temporal bones and thirty five dry skulls were used for the study. The shape of internal acoustic meatus was noted by direct inspection, whereas the dimensions such as vertical and horizontal diameter of internal acoustic meatus and its relation to important anatomical landmarks were measured in millimeters using digital vernier caliper. Internal acoustic meatus was either elliptical or round in shape. The average length and width of internal acoustic meatus was 7.51mm and 4.52 mm. The average distance from internal acoustic meatus to superior petrosal sulcus, jugular foramen, sigmoid sulcus, and clivus was 7.15mm, 7.77mm, 20.60mm, and 24.68mm respectively. The data obtained from the present study are anticipated to provide an insight for better surgical exposure of IAM and might prove to be beneficial minimizing the damage to vital structures in its proximity during any surgical procedures in this region.

Keywords: temporal bones, acoustic neuroma, internal acoustic meatus, jugular bulb

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INTRODUCTION

The internal acoustic meatus (IAM) is present on the posterior surface of the petrous part of the temporal [1]. It is a short canal, antero-superior to jugular foramen and is separated at its lateral fundus from the internal ear by a vertical plate. The upper compartment of it is a facial canal for the passage of facial nerve to its exit through the stylomastoid foramen. In the posterior part of this canal is a small depressed superior vestibular area presenting multiple openings for nerves to the utricle and anterior & lateral semicircular ducts. The lower compartment transmits the cochlear nerve through the tractus spiralis foraminosus. Behind this is inferior vestibular area that bears opening for saccular nerves. Apart from these structures, the labrynthine artery, a branch of basilar artery also passes through IAM [1]. Internal acoustic meatus is the main landmark during various surgical interventions like acoustic schwannomas, cholesteatomas, cochlear implants, stapedectomy and jugular foramen tumors [2]. In most of these surgeries acoustic preservation is an obligatory task that necessitates anatomical preservation of cochlear nerve and inner ear structures. Some of the surgical approach to IAM includes retrosigmoid approach through posterior cranial fossa which involves removal of posterior wall of internal acoustic canal, middle cranial fossa approach or the trans-labyrinthine approach [2]. Therefore understanding the topography of the anterolateral wall of the posterior cranial fossa are crucial for approaching the IAM. The present study was executed to describe the morphometry of IAM with the purpose of providing baseline information for various surgical procedures approaching or involving IAM.

MATERIALS AND METHODS

Twenty seven disarticulated, cadaveric dry temporal bones and thirty five dry skulls of unknown gender and age from the department of Anatomy, Kasturba Medical College, Mangalore were used for this study. Only well preserved, fully ossified adult temporal bones were included in the analysis and skulls showing obliterated anatomical landmarks, fractures and distorted morphological features were excluded.

Measurements were taken with help of digital vernier calipers with an accuracy of 0.01 mm. The shape of internal acoustic meatus was noted by direct inspection. The following measurements were made in millimeters:

1. Length of IAM (Figure 3).
2. Width of IAM (Figure 3).
3. Distance from midpoint of upper margin of IAM to superior petrosal sulcus (SPS) (Figure 4).
4. Distance from lateral margin of IAM to lowermost point of sigmoid sulcus (SS) (Figure 4).
5. Distance from lower margin of IAM to midpoint of upper margin of jugular foramen (JF) (Figure 4).
6. Distance from medial margin of IAM to midpoint of clivus (Figure 5).

The data collected was analyzed using the SPSS software. The maximum, minimum and average values for all parameters are calculated and tabulated.

RESULTS

Shape of IAM was observed to be either elliptical or round in the present study. Out of a total sixty two bones studied, fifty (81.96%) bones showed an elliptical IAM (Figure 1) and in twelve (18.32%) it was round (Figure 2) in shape.

Table 1: measurements on posteroinferior surface of petrous part of temporal bone

Measurements (mm)	Average	Minimum	Maximum
Length of IAM	7.51	2.98	11.72
Width of IAM	4.52	1.4	7.55
Midpoint of IAM to superior petrosal sulcus	7.15	4.8	9.37
Lateral margin of IAM to lower most point of sigmoid sulcus	20.6	13.7	30.3
Lower margin of IAM to midpoint of upper margin of jugular foramen.	7.77	4.7	13.55
Medial margin of IAM to midpoint of clivus	24.68	18.77	29.93

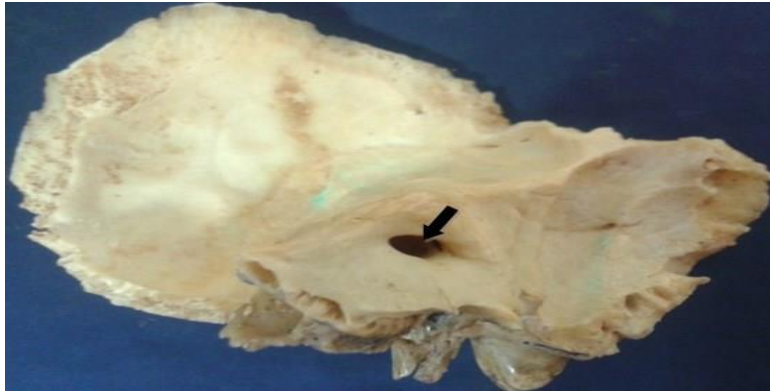


Fig 1: elliptical internal acoustic meatus

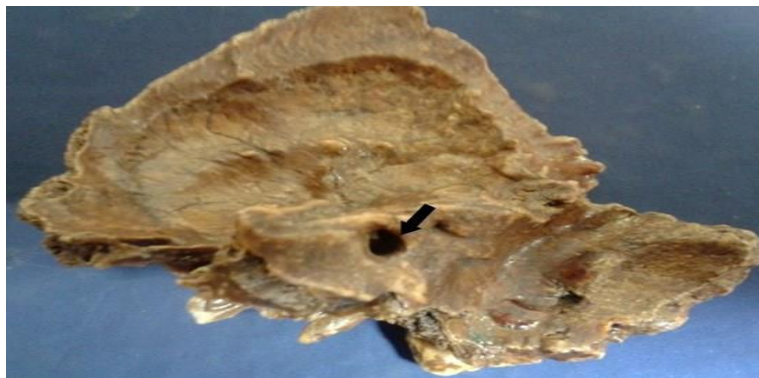


Fig 2: round internal acoustic meatus

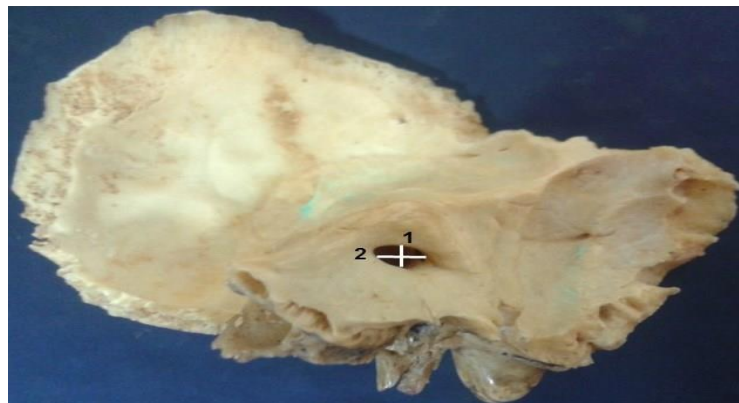


Fig 3: right temporal bone showing measurements of IAM
1 - Length of IAM; 2 - Width of IAM

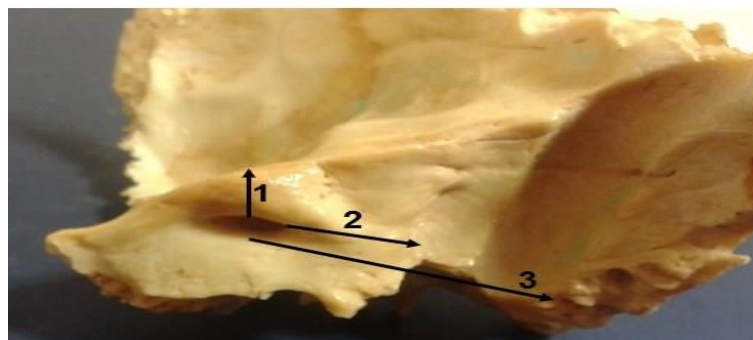


Fig 4: distance measured on right temporal bone from

1. Midpoint of upper margin of IMA to superior petrosal sulcus;
2. Lateral margin of IMA to lowermost point on posterior wall of sigmoid sulcus;
3. Lower margin of IMA to midpoint of upper margin of jugular foramen

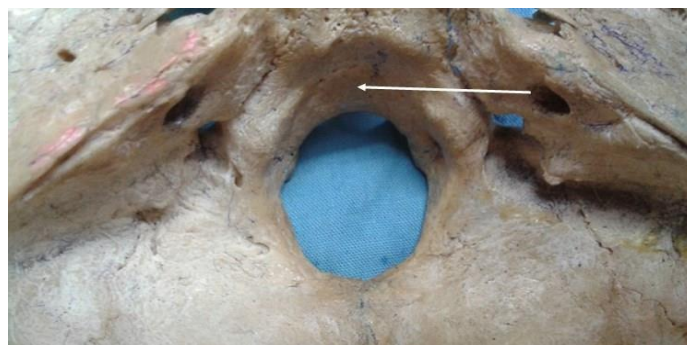


Fig 5: distance between medial margin of IMA to midpoint of clivus

Average length and width of IAM was 7.51mm and 4.52 mm respectively in the present study. The average distance from midpoint of upper margin of internal acoustic meatus to superior petrosal sulcus was 7.15mm, from lower margin of internal acoustic meatus to midpoint of upper margin of jugular foramen, from lateral margin of internal acoustic meatus to lowermost point of sigmoid sulcus was 7.77mm, 20.60 mm respectively. The average distance between internal acoustic meatus to midpoint of clivus was 24.68mm. The upper point of jugular foramen is 4 to 13 mm away from lower margin of internal acoustic meatus. In 98.4% specimens this distance was more than 4mm. Similarly the superior petrosal sulcus was 4 to 9mm away from internal acoustic meatus and in 98.36% of specimens this distance was more than 4mm. This gives an idea about the distance that can be safely drilled from upper and lower margin of internal acoustic meatus.

DISCUSSION

Surgery for acoustic neuroma is the most interesting task when it comes to either its excision or dealing with its postoperative complications, thereby demanding a thorough knowledge of its anatomy. The most important step in the removal of acoustic neuroma is the drilling of IAM and further more important is bearing in mind its proximity to jugular bulb and the endolymphatic sac. Owing to their easy identification and rigid nature, the bony parameters are more reliable and suitable when compared to soft tissue landmarks. Kolagi et al. worked on 224 dry human temporal bones and reported the vertical diameter of IMA ranging between 3-7mm and the horizontal diameter ranging between 4mm and 11mm [3]. In the same study the authors stated that a 4mm safe area was available for drilling the internal acoustic canal inferiorly and 6mm laterally without encountering jugular bulb and endolymphatic sac, respectively. Similarly Koval J et al, noted that the average dimensions of IMA was 9.3mm horizontally and 4.5mm vertically as well as distance from superior border of IMA to superior border of petrous was 5.5 mm, inferior border of IMA to highest point on jugular bulb was 6.6 mm and lateral wall of IMA to endolymphatic sac was 11.2 mm [4]. In patients with vestibular tumors the relation of IMA to jugular fossa gains paramount importance. Because here a little excess bone should be drilled to expose the facial nerve and safe guard it. High jugular fossa endangers the jugular bulb in such cases [5].

Knowing the average distance of IAM from the superior petrosal sulcus gives an idea about the amount of bone that can be safely drilled in the superior direction from the posterior border of IMA [6]. We observed a minimum distance of 4.8mm from the midpoint of upper border of IMA to superior petrosal sulcus and a maximum of 9.37mm. Moeller radiologically estimated the width and length of IAM as 5mm and 8mm respectively. Whereas, the present study showed average length of IMA as 7.5m (ranging between 2-11mm) and average width as 4.5mm (ranging between 1-7 mm) [7].

Krajewski and Kukwa studied the surgical anatomy of petrous pyramid area in fresh cadavers and dry skulls and opined that the supracerebellar - infratentorial approach allows for a more medial angle surgical approach and makes it possible to reach the IMA fundus, safeguarding endolymphatic spaces [8]. Tulika & Sunil reported that about 5mm of bone can be safely drilled from the posterior lip of IMA without damaging jugular bulb, superior petrosal sulcus or endolymphatic sac [6]. Whereas, in present study, 98.36% samples

showed the distance between superior petrosal sulcus IMA as more than 4mm. Therefore a 4mm safe zone is available for drilling IMA superiorly. However, inferiorly 5mm of distance was observed in the present study which is comparable to the previous reports [3,6].

Table 2: distance in mm from IMA to different anatomical landmarks reported by previous authors

To	Natekar & D'souza (2011)	Kolagi et al. (2010)	Tulika & Sunil (2009)	Krajewski &, Kukwa (1999)	Present study
SPS	4.5	5.6	5.11	3.9	7.15
JF	8.6	6.22	8.21	4.1	7.77
SS	24.08	38.51	-	35.8	20.60

CONCLUSION

Since the parameters taken in this study to describe the anatomical relation of IAM with the neighboring mentioned structures are bony and rigid, they serve as adequate bony landmarks to establish the precise position preoperatively by high resolution scans. These data can be utilized for presurgical evaluation of proximity of neighboring neurovascular structures from the IMA during various surgical procedures and thereby minimize the risk of postoperative complications.

Conference presentation: this work is presented as a poster in NATCON 2013 of Anatomical Society of India, titled as "Morphometric analysis of internal acoustic meatus in South Indian population", held in Chandigarh, INDIA.

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