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Revisit to the Accuracy of Arcuate eminence as a Surgical landmark for Superior semicircular canal in Middle cranial fossa surgeries

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ABSTRACT

Introduction-

The arcuate eminence is a well-recognized anatomical landmark on the petrous part of the temporal bone and has historically been used as a reference point for identifying the superior semicircular canal. Precise localization of the superior semicircular canal is critical in otologic and neurotologic surgeries. It is used in surgery of the middle cranial fossa as a reference point to locate the internal acoustic canal within the temporal bone. This study aims to evaluate the anatomical precision of the arcuate eminence as a surface landmark for the superior semicircular canal, with a distinct focus on determining the part of the canal that is exposed.

Materials and methods –

A cross sectional study was done on 20 dry temporal bones from February 2025 till April 2025. The bones were dissected in the Temporal bone dissection lab of department of Otorhinolaryngology & Head and Neck surgery, R L Jalappa Hospital, Tamaka, Kolar. The arcuate eminence in these specimens is recognized as a small, raised ridge or rounded elevation located near the midpoint of the petrous part of the temporal bone. Meticulously drilling Over the Arcuate Eminence to gradually thin the bone,the ivory coloured bony outline of the SSC start to appear. The canal will appear as a curved, hollow structure within the petrous bone. The angle formed between the long axis of the arcuate eminence and the tangential line connecting the petrous apex to the superior petrosal sinus will be analysed.

Additionally, the distance from the arcuate eminence to the inner part of squamous part of temporal bone also analysed. These are measured with the help of a divider, protractor and ruler.

Results-

Doom of superior semi circular canal was corresponding to arcuate eminence in 11 specimens (55%) and not corresponding to arcuate eminence in 9 specimens (45%).

The angle between the arcuate eminence and the superior petrosal sulcus varied among specimens, with a mean angle of

37.65°.

The distance between the arcuate eminence and the inner squamous part of the temporal bone showed variability, with a mean distance of 19.9 mm

Conclusion-

The current study reaffirms that while the arcuate eminence is often used as a superficial landmark for locating the superior semicircular canal during middle cranial fossa surgeries, its accuracy as a reliable and consistent guide is limited..

Keywords: *Arcuate eminence, Superior semicircular canal, Middle cranial fossa surgery, Temporal bone dissection, Anatomical landmarks, Skull base surgery, Otologic surgery, Neurotologic procedures, Surgical anatomy, Anatomical variability*

1. INTRODUCTION

Background

Middle cranial fossa surgeries encompass a range of advanced otologic and neurosurgical procedures that provide access to vital structures located at the central skull base. These surgeries are primarily performed through the temporal bone and are employed to address pathologies involving the internal auditory canal, superior semicircular canal, cochlea, vestibule, facial nerve, and petrous apex[1].

Anatomical landmarks are essential for accuracy and safety in skull base procedures. The temporal bone is a highly intricate structure with many important neurosvascular elements, and mistake in surgical approach can result in dreadful consequences.The arcuate eminence and the superior semicircular canal (SSC) are crucial anatomical structures in skull base surgeries, particularly those involving the middle cranial fossa and petrous temporal bone[2-3].

The arcuate eminence is a well-recognized anatomical landmark on the petrous part of the temporal bone and has historically been used as a reference point for identifying the superior semicircular canal[4]. During procedures such as excision of vestibular schwannoma, repair of superior semicircular canal dehiscence (SSCD), and decompression of the internal acoustic canal, accurate identification of the SSC is essential to avoid damaging the surrounding delicate neurovascular tissues[5]. The arcuate eminence offers a surface reference that enables the surgeon to limit the amount of drilling performed on the bone while obtaining access to the inner ear anatomy, thus avoiding excessive removal of bone and the consequent complications.

In the context of skull base and neurotological surgery, the arcuate eminence serves not only as a superficial marker for the superior semicircular canal but also as a key topographical reference for orienting the surgeon within the middle cranial fossa. Its spatial relationship to critical anatomical structures—such as the greater superficial petrosal nerve, petrous apex, and internal auditory canal—enhances its utility during dural elevation and anterior petrosectomy. Moreover, its early exposure during surgical dissection makes it a reliable initial cue for defining safe operative planes, particularly in complex approaches requiring preservation of labyrinthine and neurovascular structures.

One of the major issues with using the arcuate eminence as a landmark is anatomical variability. In some cases, the arcuate eminence is not well defined or may be entirely absent, making it difficult to rely on as a consistent guide. Additionally, the superior semicircular canal may not always lie directly beneath the arcuate eminence, leading to potential inaccuracies in localization. These variations highlight the need for a reassessment of its role as a dependable surgical reference point[6].

As anatomical research advances, the need to revisit the traditional surgical landmarks becomes increasingly important. The arcuate eminence has been a widely used reference point for decades, yet emerging evidence suggests that its accuracy in guiding superior semicircular canal localization may not be as absolute[7]. A thorough understanding of this anatomical relationship is crucial for ensuring safe and effective middle cranial fossa surgeries and for improving the overall precision of otologic and neurotologic procedures.

Previous studies have demonstrated inconsistencies in the spatial correlation between the arcuate eminence and the underlying superior semicircular canal, raising concerns about its accuracy as a surgical guide. This study aims to evaluate the anatomical precision of the arcuate eminence as a surface landmark for the superior semicircular canal, with a distinct focus on determining the part of the canal that is exposed.

2. MATERIALS AND METHODS

A cross sectional study was done on 20 dry temporal bones from FEBRUARY 2025 till MARCH 2025. The bones were dissected in the Temporal bone dissection lab of department of Otorhinolaryngology & Head and Neck surgery, R L Jalappa Hospital, Tamaka, Kolar. The study was started after obtaining Institutional Ethics committee clearance -

(SDUAHER/R&D/CEC/SDUMC-PG/14/NF/2025-26)

The arcuate eminence in these specimens is recognized as a small, raised ridge or rounded elevation located near the midpoint of the petrous part of the temporal bone. Meticulously drilling Over the Arcuate Eminence to gradually thin the bone. Drill cautiously in a slow, controlled manner to avoid excessive removal of bone as drilling progresses, the ivory coloured bony outline of the SSC start to appear. The canal will appear as a curved, hollow structure within the petrous bone. The angle formed between the long axis of the arcuate eminence and the tangential line connecting the petrous apex to the superior petrosal sinus will be analysed.

Additionally, the distance from the arcuate eminence to the inner part of squamous part of temporal bone also analysed. These are measured with the help of a divider, protractor and ruler.

Statistical analysis

The minimum and maximum values and mean and standard deviation values from the descriptive statistics for the angle and distance measurements were given. The number and percentage values from the descriptive statistics for categorical variables were also given. The normal distributive control was done by Shapiro-Wilk test for the angle and distance values. The difference between right-left angle and right distance-left distance measurements were evaluated by paired t test among parametric tests. Direct variant analysis method (ANOVA) was used for the investigation of angle and diameters between each other found in the right and the left. Statistical significance value was considered as (p) 0.05 for all statistical comparisons.

3. RESULTS

A total of 20 dry temporal bone specimens were dissected and analysed.

- 12 out of 20 specimens (60%) had a prominent arcuate eminence,8 specimens (40%) had rudimentary arcuate eminence.
- Doom of superior semi circular canal was corresponding to arcuate eminence in 11 specimens (55%) and not corresponding to arcuate eminence in 9 specimens (45%).
- The angle formed between the long axis of the arcuate eminence and the tangential line connecting the petrous apex to the superior petrosal sinus were measured and results summarized in Table 1.

Table 1 : Angle formed between the long axis of the arcuate eminence and the line connecting the petrous apex to the superior petrosal sinus.

Angle (degrees)	Number of temporal bones(%) (n=20)
35^0	6(30%)
37^0	1(5%)
38^0	7(35%)
40^0	6(30%)

- The study found that the angle between the arcuate eminence and the superior petrosal sulcus varied among specimens, with a mean angle of 37.65°. The angles ranged from a minimum of 35° to a maximum of 40°, indicating slight anatomical variations among individuals.
- The distance between long axis of arcuate eminence and inner aspect of squamous part of temporal bone is documented and results summarized in Table 2.

Table 2: Distance between long axis of arcuate eminence and inner aspect of squamous part of temporal bone

Distance(mm)	**Number of temporal bones(%) (n=20)**
15mm	2(10%)
16mm	1(5%)
17mm	1(5%)
18mm	2(10%)
19mm	2(10%)
20mm	3(15%)
21mm	3(15%)
23mm	6(30%)

- The distance between the arcuate eminence and the inner squamous part of the temporal bone showed variability, with a mean distance of 19.9 mm. The shortest recorded distance was 15 mm, while the longest was 23 mm.
- Although the superior semicircular canal (SSC) corresponded to the arcuate eminence (AE) in 11 temporal bones, the long axis of the arcuate eminence and the long axis of the superior semicircular canal did not align in these case.
- Furthermore, in five temporal bones, the superior semicircular canal was positioned slightly medial to the arcuate eminence, highlighting anatomical variability in the relationship between these structures.

Figure -1: A black line showing -Arcuate eminence - A small, raised ridge or rounded elevation located near the midpoint of the petrous part of the left temporal bone.

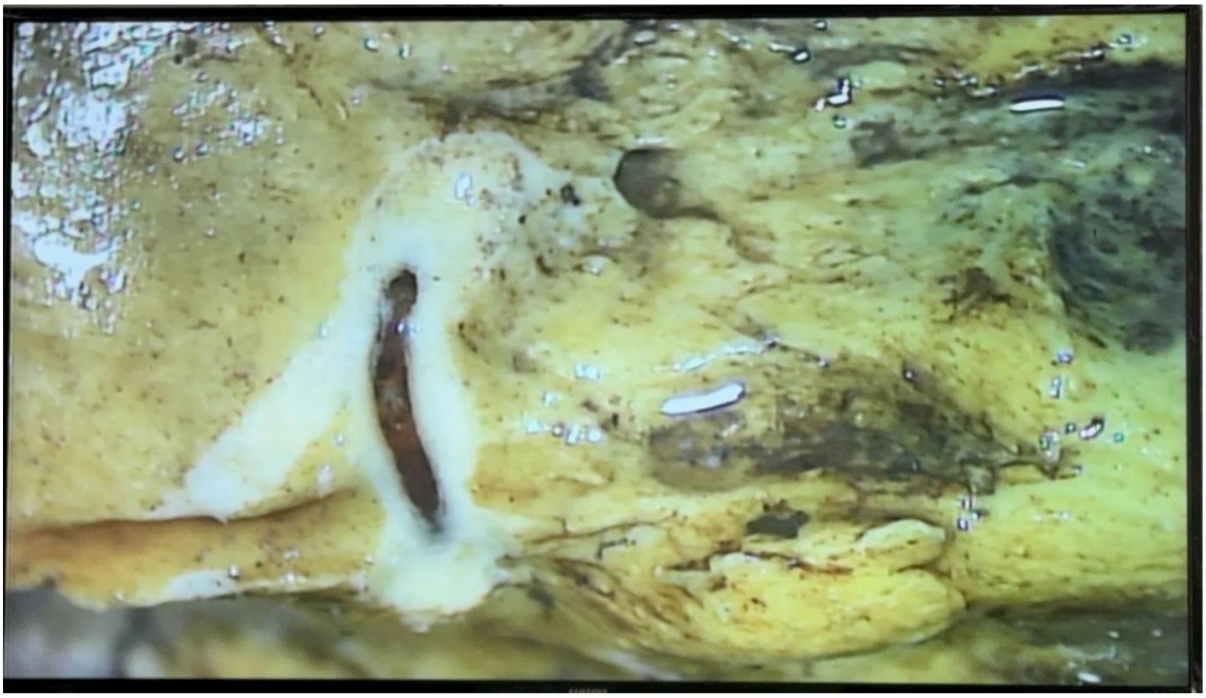

Figure-2: Picture showing arcuate eminence corresponding to doom of superior semicircular canal but long axis of both the structures are not corresponding with each other.

Figure-3:Picture showing the distance between long axis of arcuate eminence to inner part of squamous part of left temporal bone.

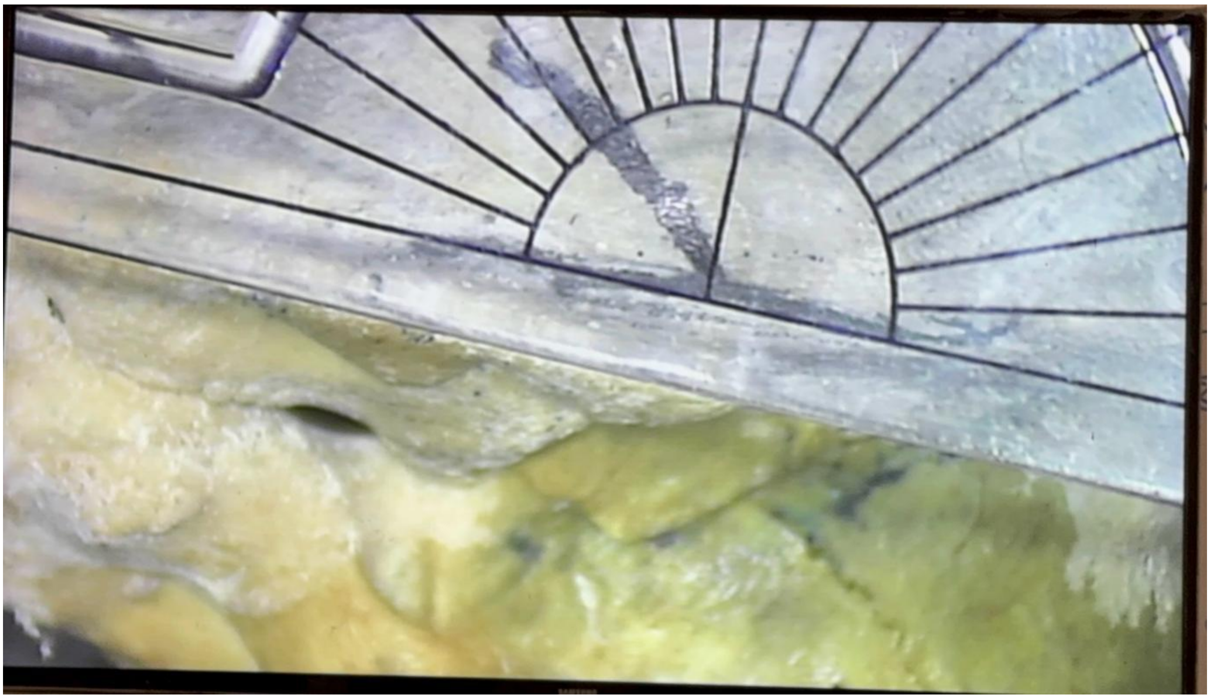

Figure-4 : Picture showing the angle formed between the long axis of the arcuate eminence and the line connecting the petrous apex to the sigmoid sinus.

4. DISCUSSION

The present study aimed to reassess the accuracy and reliability of the arcuate eminence (AE) as a surgical landmark for localizing the superior semicircular canal (SSC) during middle cranial fossa surgeries[8-10]. The findings contribute important insights into the anatomical variability of this relationship and its implications for skull base surgery.

One of the key strengths of this study lies in its direct anatomical dissection of 20 dry temporal bones, allowing precise visualization and measurement of the AE-SSC relationship. The analysis revealed that although the SSC was found to correspond with the AE in 55% of the specimens, the long axes of the AE and SSC did not align in any of those cases. This suggests that while AE may overlie the SSC doom, it does not accurately reflect the orientation of the canal, which has significant implications for surgical navigation and precision.

An additional observation was that in five specimens, the SSC was located slightly medial to the AE, further underscoring the anatomical variability and potential risk of over-reliance on this structure during surgery. These findings are consistent with more recent literature, such as the studies by Satoshi tsutsumi et al (2021)[11] and Fábio Pires Santos et al. (2018)[12], both of which questioned the consistent topographical correlation between the AE and the SSC.

The mean angle between the long axis of the AE and the line connecting the petrous apex to the superior petrosal sulcus was calculated as 37.65°, with values ranging from 35° to 40°. This relatively small range of variation suggests a potential for angular guidance, but only when the AE is well-defined and in conjunction with other anatomical landmarks. The distance between the AE and the inner aspect of squamous part of the temporal bone also varied, with a mean of 19.9 mm (ranging from 15 mm to 23 mm), reinforcing the need for individualized assessment.

Among the advantages of using the AE is its ease of identification during surgical exposure and its superficial position, which reduces the extent of drilling required to access the SSC. It is particularly helpful in teaching anatomy and providing an initial point of reference during surgical approaches. However, the disadvantages stem from the lack of consistency in its presence and prominence, and the non-parallel orientation to the SSC, which may result in inaccurate localization if used in isolation.

The limitations of this study include its modest sample size and the use of dry temporal bones, which, while suitable for structural analysis, do not account for soft tissue landmarks or real-time surgical challenges. Furthermore, there is no radiological correlation provided in this study, which could have further validated the anatomical findings.

Despite these limitations, the strengths of the study lie in its methodical approach, direct dissection, and quantitative measurement of both angles and distances, offering clear data for surgical application. The study emphasizes the importance of integrating imaging modalities, such as high-resolution CT scans, with anatomical landmarks like the AE to enhance intraoperative accuracy.

5. CONCLUSION

The current study reaffirms that while the arcuate eminence is often used as a superficial landmark for locating the superior semicircular canal during middle cranial fossa surgeries, its accuracy as a reliable and consistent guide is limited

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