PREVALENCE AND MORPHOLOGICAL PATTERNS OF KOERNER'S SEPTUM IN THE INDIAN POPULATION: A HIGH-RESOLUTION CT STUDY OF 250 TEMPORAL BONES

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ABSTRACT

Background:

Koerner's Septum (KS) is an important anatomical variant of the temporal bone that results from the persistence of the petrosquamosal suture due to incomplete postnatal pneumatization. Located within a surgically critical region, KS has significant implications in otologic procedures, particularly mastoidectomy. Failure to identify KS preoperatively may result in incorrect surgical plane entry, intraoperative disorientation, incomplete disease clearance, and an increased risk of injury to vital structures such as the facial nerve and labyrinth. Despite its clinical relevance, radiological data describing the prevalence and morphology of KS in the Indian population remain limited.

Objective:

To determine the prevalence, laterality, completeness, and anatomical distribution of Koerner's Septum in the Indian population using high-resolution computed tomography (HRCT) of the temporal bone.

Materials and Methods:

A retrospective observational study was conducted on 250 HRCT scans of the temporal bone from individuals aged over 18 years. Radiologically normal scans were included, while scans showing temporal bone pathology or evidence of previous otologic surgery were excluded. Each scan was evaluated for the presence of Koerner's Septum, its laterality (unilateral or bilateral), completeness (complete or incomplete), and anatomical level. Descriptive statistics were used for analysis.

Results:

Koerner's Septum was identified in 72.0% (180/250) of temporal bones. Unilateral KS was more common, observed in 76.1% (137/180) of cases. Incomplete septa predominated, accounting for 83.3% (150/180). The most frequent anatomical level of KS was at the head of the malleus, followed by the superior semicircular canal and the tympanic sinus.

Conclusion:

In the Indian population, KS has a high prevalence and a wide range of morphologies. To minimize difficulties during mastoidectomy and to ensure optimal surgical planning, preoperative HRCT identification is crucial. Surgical awareness is necessary because incomplete, unilateral septa are more common at important surgical landmarks.

Keywords: Koerner's Septum, Petrosquamosal Suture, Temporal Bone Anatomy, HRCT, Prevalence, Indian Population, Mastoidectomy.

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INTRODUCTION

The human temporal bone, which houses the organs of hearing and balance, possesses a complex anatomy that is critically important in otologic and neurotologic surgery. A key feature, the postnatally pneumatized mastoid air cell system, can be significantly influenced by persistent embryological remnants, most notably Koerner's Septum (KS) [1]. Understanding KS requires knowledge of temporal bone embryology. The bone forms from the fusion of distinct parts, primarily the squamous and petrous portions, with KS originating at their developmental interface [2]. The petrous part (otic capsule) ossifies from endochondral bone, while the squamous part develops via intramembranous ossification; these two centers are initially separated by the petrosquamous suture [3]. Postnatally,

pneumatization typically leads to the resorption of this suture, forming a unified mastoid cavity [4].

Koerner's Septum is the clinical manifestation of a persistent petrosquamous suture, a bony lamina resulting from incomplete pneumatization that compartmentalizes the mastoid air cell system, serving as a fossilized boundary between the petrous and squamous bone [5,6]. Anatomically, KS extends from the tegmen tympani postero-inferiorly toward the mastoid apex, coursing lateral to the facial canal and superior to the middle ear, placing it directly within the surgical field of mastoidectomy [7].

During mastoid surgery, KS poses critical risks. It can be mistaken for the deeper medial mastoid wall, causing surgical disorientation and potentially leading to iatrogenic injury of the facial nerve or lateral semicircular canal [8,9]. By acting as a physical barrier, KS can also contribute to aditus ad antrum blockage, impairing mastoid ventilation and predisposing to chronic otitis media and attic retraction cholesteatomas [10]. Crucially, KS can conceal underlying pathology; failure to identify and remove it during cholesteatoma surgery may leave residual disease hidden medially, necessitating revision procedures [11].

The majority of anatomical and radiological research have concentrated on Caucasian, Middle Eastern, and East Asian populations, despite the fact that KS is well-documented in otologic literature [12]. With only two small studies (Vaid et al. [2], n=60; Deepthi et al. [5], n=50) revealing wildly disparate prevalence rates of 48.3% and 54.3%, respectively, information on its prevalence and morphological features across the Indian population is still noticeably lacking. Population-specific data are essential for improving clinical practice since anatomical variances show substantial ethnic and geographic variety.

Thus, the purpose of this study was to use HRCT to methodically examine the prevalence, laterality, completeness, and anatomical distribution of Koerner's Septum in a sizable Indian population cohort. We predicted that incomplete, unilateral septa would predominate in the Indian population's KS prevalence, which would be different from previously documented rates in other ethnic groups.

Materials and Methods

Study Design and Ethical Approval

A retrospective observational study was conducted after obtaining approval from the Institutional Ethics Committee of SRM Medical College Hospital & Research Centre, Kattankulathur, Chengalpattu, Tamil Nadu (Ethical Clearance No.: SRMIEC-ST0825-2817). The study involved the analysis of pre-existing radiological data to investigate the anatomical characteristics of Koerner's septum (KS).

Study Setting and Duration

The study was carried out at the Department of Radiology, SRM Medical College Hospital & Research Centre, Kattankulathur, Chengalpattu, Tamil Nadu. High-Resolution Computed Tomography (HRCT) temporal bone images obtained between January 2025 and June 2025 were retrospectively reviewed.

Study Population and Sample Size

The study population comprised all individuals who underwent HRCT imaging of the temporal bone during the defined study period. Consecutive sampling was employed to include all eligible cases. A total of 250 HRCT DICOM images of the temporal bone were included in the final analysis.

Inclusion and Exclusion Criteria

The study population encompassed all individuals who underwent temporal bone HRCT scans during a defined retrospective period, with consecutive sampling applied to all eligible cases. Strict eligibility criteria were implemented. Inclusion was limited to HRCT scans from individuals aged 18 years and above with radiologically normal temporal bone findings. Scans demonstrating temporal bone pathology, prior surgical history in the region, or significant imaging artifacts were excluded [13].

Image Acquisition and Analysis

The methodological procedure involved systematic image procurement and screening, followed by detailed analysis using diagnostic workstations capable of multi-planar reconstruction. The image evaluation specifically focused on three key parameters: the presence and prevalence of Koerner's Septum, its laterality (unilateral or bilateral), and its anatomical level (e.g., head of malleus, superior semicircular canal, tympanic sinus) [14,15]. All findings were meticulously documented using a structured data collection form while maintaining patient confidentiality through anonymization protocols.

RESULTS

A total of 250 temporal bone High-Resolution Computed Tomography (HRCT) examinations were analysed, comprising 130 from male and 120 from female patients. Koerner's Septum (KS) was identified as a prevalent anatomical variant, present in 180 cases, constituting 72.0% of the cohort. The absence of KS was noted in the remaining 70 cases (28.0%).

Among the 180 KS-positive cases, laterality was predominantly unilateral (137 cases, 76.1%), with 43 cases (23.9%) being bilateral. No cases of bilateral complete Koerner's septum were observed in this study, underscoring its rarity. Morphological classification showed that the vast majority of KS were incomplete (150 cases, 83.3%), while complete septa were observed less frequently (30 cases, 16.7%) all being unilateral (Table1 & Fig-1).

Table 1: Prevalence and Radiological Characteristics of Koerner's Septum (KS) in a Cohort of 250 Temporal Bone CT Images

CATEGORY	CATEGORY	NUMBER (N)	PERCENTAGE (%)
Overall Occurrence	Presence Of KS	180	72.0%
	Absence Of KS	70	28.0%
Laterality (N=180)	Unilateral	137	76.1%
	Bilateral	43	23.9
Completeness (N=180)	Complete KS	30	16.7%
	Incomplete KS	150	83.3%
Anatomic Level (N=180)	At The Level of Head of Malleus	72	40.0%
	At The Level of Superior Semicircular Canal	63	35.0%
	At The Level of Tympanic Sinus	45	25.0%

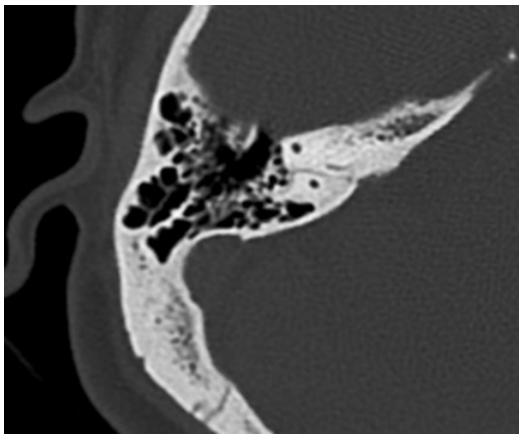

Fig 1: Incomplete Koerner's Septum at the level of Superior Semicircular Canal

The anatomical distribution of KS demonstrated a characteristic pattern, with the most frequent location at the level of the head of the malleus (40.0%, 72/180), followed by the superior semicircular canal (35.0%, 63/180), and the tympanic sinus (25.0%, 45/180). This distribution provides crucial topographic information for surgical navigation in the mastoid region.

DISCUSSION

Koerner's Septum (KS) is a critical anatomical variant of the temporal bone, representing a persistent petrosquamous suture that can significantly influence surgical orientation and outcomes during mastoidectomy, as its presence can complicate access, leading to incomplete disease excision and an increased risk of iatrogenic injury or residual cholesteatoma [8].

The detailed radiological profiling is indispensable for pre-operative planning, allowing surgeons to anticipate and navigate this variable anatomical barrier, thereby mitigating the risk of incomplete dissection and iatrogenic injury. Table 1 presents a comparison of the prevalence and characteristics of KS from several studies.

In contrast to previous research, the present study demonstrates a significantly higher prevalence of KS, with an overall occurrence of 72.0% (Table 2) that vastly exceeds the rates documented in Malaysian (29.2%), Caucasian (33.1%), and Brazilian (41.3%) populations [5]. Notably, even compared to other Indian studies, our reported prevalence is substantially higher than the 48.3% reported by Vaid et al.[2] and the 54.3% by Deepthi et al.[5]

Table 2: Reported Variations in Koerner's Septum Prevalence and Morphology

Authors	Population	Sample Size (N)	Prevalence of KS	Unilateral	Bilateral	Complete KS
Present Study (2024)	Indian	250	72.0%	76.1%	23.9%	16.7%
Chew et al. (2017)	Malaysian	113	29.2%	-	-	-
Deepthi et al. (2016)	South Indian	70	54.3%	-	-	-
Vaid et al. (2015)	Indian (Mixed)	180	48.3%	-		
Julius et al.	Caucasian	208	33.1%	68.1%	31.9%	22.5%

(2014)						
Baptista et al. (1990)	Brazilian	150	41.3%	-	-	

Regarding laterality, the observed predominance of unilateral KS (76.1%) closely corresponds with the findings of Julius et al. [16] (68.1%) (Table 2/Fig 1 & Fig 5), suggesting a common asymmetric pattern of petrosquamous suture resorption across populations. However, morphological analysis reveals a distinct profile within our cohort. The incidence of complete KS (16.7%) (Fig 2) is lower than the 22.5% reported by Julius et al. [16] 2014 but aligns closely with the 18.6% documented by Baptista et al, 1990 [17]. This indicates that while KS is more prevalent in our population, its tendency to form a complete, compartmentalizing barrier is consistent with certain global trends.

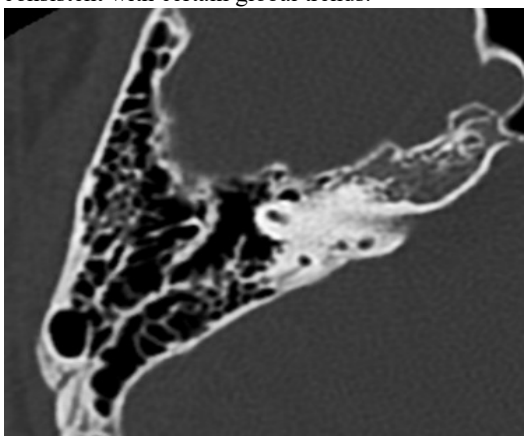

Fig 2: Complete Koerner's Septum at the level of Superior Semicircular Canal

Fig 3: Koerner's Septum at the Level of Head of Malleus

The anatomic distribution of KS elucidated in this study provides a critical topographic guide for surgeons. The most frequent location at the level of the head of the malleus (40.0%) (Fig 3, Table 3) aligns closely with the findings of Lee et al. (45.3%) and Silva et al. [18] (52.0%), reinforcing its potential role in attic block pathology (Baptista et al., 1990) [17]. The incidence at the level of the superior semicircular canal (35.0%) (Fig 1, Table 3) was higher than that reported in some studies but notably lower than the 41.6% documented by Koc et al.,[9] while the occurrence at the tympanic sinus (25.0%) (Fig 4, Table 3) was consistent with most comparative populations.

Table 3: Comparison of the Anatomic Level of Koerner's Septum Among Populations.

Authors	Population Sample Size (N)	Level of Head of Malleus	Level of Superior Semicircular Canal	Level of Tympanic Sinus
Present Study (2024)	250	40.0%	35.0%	25.0%
Silva et al. (2021)	102	52.0%	28.0%	20.0%
Lee et al. (2019)	95	45.3%	31.6%	23.2%
Koc et al. (2020)	89	38.2%	41.6%	

These disparities in prevalence and morphology may arise from methodological, genetic, or ethnic variations. The significantly higher prevalence in our cohort suggests a strong ethnic predisposition within the studied Indian population for the retention of the petrosquamous suture [18]. The radiological data indicate a unique anatomical landscape characterized by a high frequency of KS, albeit often in an incomplete form. To clarify these population-specific trends and their definitive clinical implications for surgical complication rates, further prospective studies correlating these radiological classifications with intraoperative findings and patient outcomes are necessary [19].

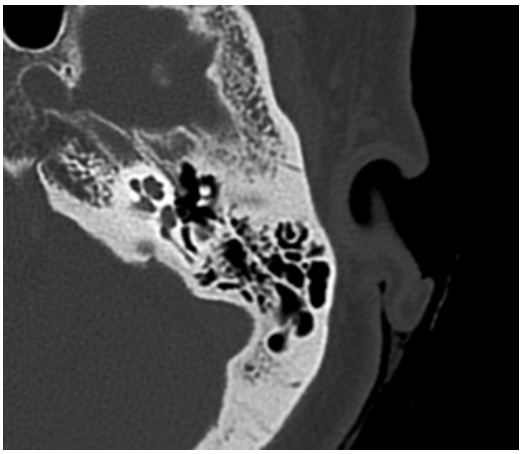

Fig 4: Koerner's Septum at the Level of Tympanic Sinus

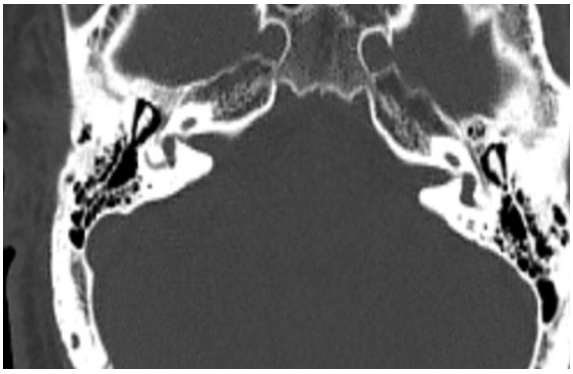

Fig 5: Bilateral Koerner's Septum at the level of Head of Malleus

The role of environmental factors, particularly the burden of middle ear infections in early childhood, could not be discounted. It is plausible that recurrent otitis media during critical developmental periods disrupts the normal process of mastoid pneumatization and suture resorption, leading to a higher rate of septal persistence. This hypothesis, however, remains speculative and warrants validation through dedicated longitudinal studies comparing temporal bone development in cohorts with and without a history of early-life otitis media [20].

The observed disparities in the prevalence and morphology of Koerner's septum likely stem from a confluence of methodological, genetic, and ethnic factors. The pronounced frequency in our cohort suggests a potential anatomical predisposition within the studied population for retention of the petrosquamous suture [21]. This unique anatomical landscape, characterized by a high frequency of predominantly incomplete septa, underscores the necessity for population-specific surgical awareness. Furthermore, integrating morphometric data from previous studies, which detailed variations in septal thickness across different portions, adds a critical dimension for preoperative risk stratification [22]. To definitively link these radiological and morphometric observations to surgical safety and efficacy, future prospective studies that directly correlate these classifications with intraoperative difficulty and long-term patient outcomes are essential [23].

CONCLUSION

This study establishes Korner's septum (KS) as a highly prevalent and morphologically variable structure in the Indian population, demonstrating a strong predilection for unilateral and incomplete forms. The septum most frequently occurred at surgically critical levels the head of the malleus and superior semicircular canal highlighting its potential as a significant surgical barrier that complicates access and increases risks to vital structures like the facial nerve. These findings underscore the essential role of preoperative high-resolution CT for precise identification and mapping of KS. Surgeons must recognize both its presence and variable morphology to ensure safe mastoid cavity navigation. This work provides crucial population-specific data for improving surgical outcomes, while further prospective studies correlating radiological classifications with intraoperative findings are recommended to strengthen clinical correlations.

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Data availability: The data generated and analysed in this study can be obtained from the corresponding author upon reasonable request.

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Conflicts of Interest: There are no conflicts of interest

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