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COG – Anatomy Revisited

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Abstract

Introduction: Endoscopic display of temporal bone structures is currently the standard technique for comprehending the complicated architecture and hidden recesses. To analyze the anatomy of Cog and its adjacent structures, we used endoscopes' wide field magnification and an angled view, to understand its importance as a prominent landmark for various adjacent vital structures.

Objectives: To analyze and document the variations in presentation, orientation, and extent of cog.

Materials And Methods: Thirty-one adult cadaveric temporal bone specimens were dissected at our center. The Trans-canal approach was used to visualize the structures in the Epitympanum. We observed different variations of Cog, the findings were well analyzed and documented.

Results: Out of 31 specimens, cog was found to be a bony structure in 28 out of 31 specimens (90.32%) and pneumatized in 3 specimens (9.67 %). In 23 (74.2%) of them Cog was coronal in orientation whereas in the rest 8 (25.8%) it was obliquely oriented. The Cog reached up to the cochleariformis process in 12 (38.7%) bones whereas in rest 19(61.3%) of them, were just short of cochleariformis process.

Conclusion: Through the outcome of this study, we conclude that the pathology of cholesteatoma does not depend upon the prominence or the orientation of the cog but depends on whether the cog is partial or complete in its extent to the cochleariformis process.

Keywords: Cog, Endoscopy, Epitympanum

Introduction

Endoscopic surgery was developed by urologists until the end of the nineteenth century, when Max Nitze (1849–1906) pioneered endoscopic examination of the bladder. Philipp Bozzini, two centuries ago, was thought to have invented the first endoscope. Endoscopic procedures have recently advanced, allowing for a novel application of this tool in Middle ear endoscopic surgery.

With the help of an endoscope with various angulations, otologic surgeons have been able to investigate all of the hidden places in the middle ear that are often not visible with a microscope, allowing for an extraordinarily thorough picture of the "in vivo" anatomy of the middle ear, such as the sinus tympani, the anterior epitympanic space, and the pro-tympanic region.[1]

It also allows for a better understanding of middle ear physiology and ventilation pathways that, if disrupted, can cause pathology.[2]

The objective of this article is to study the clinical anatomy of the epitympanum, to revisit a not so well understood structure in the attic, called cog and to investigate the adjacent anatomical relationship with this landmark.

Objectives:

1. Extension of Cog
2. Orientation of Cog, and
3. Presentation of Cog.

Materials And Methods

31 Adult cadaveric temporal bones were dissected from September 2020 to April 2021 at the Department of Otolaryngology, obtained from the Department of Anatomy in Sri Devaraj Urs Medical college, Kolar, Karnataka. Institutional Ethical Clearance was sought to proceed with the Study. The procedures used in this study adhere to the tenets of the declaration of Helsinki.

All dissections were performed with 0-degree and 45-degree 3-mm rigid endoscopes (Karl Storz Endoscopes) Through the ear canal, a posteriorly based tympanomeatal flap was elevated to gain access to the middle ear. The tympanic membrane was then carefully dissected off the malleus lateral process and handle in a superior to inferior fashion, without disruption of the ligaments, folds, and chorda tympani nerve. The 0-degree and 45-degree endoscopes were placed at the pro tympanum and the anterior tympanic isthmus to visualize the cog and its adjacent structures. An atticotomy was then performed by curetting the scutum to expose the epitympanum through endoscopic transcanal approach. The epitympanic space was inspected with the 45-degree endoscope. The incus and the malleus head were subsequently removed to fully expose the cog, tensor fold, epitympanic space, and supratubal recess region. Still images were taken for review and documentation. The variations of transverse crest (cog), tensor fold, anterior epitympanic space, and supratubal recess were observed.

Results:

All the 31 Adult cadaveric temporal bones were dissected from the preserved anatomic specimens. The area in between the tensor tympani tendon and the incudo-stapedial joint was patent in all specimens and did not contain any mucosal folds. The lateral incudo-mallear folds and the lateral mallear folds were intact in all the specimens. The suspensory ligaments and folds were found to be variable but incomplete in all of our specimens. The tensor fold had a variable position and relationship to the cog.

Out of 31 specimens, Cog was a bony structure in 28 out of 31 specimens (90.32%) and pneumatized in 3 specimens (9.67 %). In 23 (74.19%) of them, cog had coronal orientation whereas in the rest 8 (25.80%) it was oblique in orientation. The cog reached up to the cochleariformis process in 12 (38.70) bones whereas in rest 19 (61.29%) of them, it just reached short of cochleariformis process. Among our specimen cholesteatoma was found in 5 of them.

Discussion:

The middle ear spaces develop from four endothelial sacs, or pouches, extending from the eustachian tube between the third and seventh fetal months, as shown by proctor. Mucosal folds are formed where these pouches come into contact. [3, 4]

The epitympanum is formed by both the saccus anticus and the saccus medius. After passing through the anterior tympanic isthmus, the saccus medius splits into three saccules: Anterior saccule forming the Anterior compartment of attic, Medial saccule forms the superior Incudal space and Posterior saccule extends posteriorly between the long process of incus and stapes to form medial wall of the mastoid antrum. The fusion of saccus Anticus and the anterior saccule of saccus medius forms the Tensor tympani fold which separates the anterior epitympanic recess superiorly from supratubal recess inferiorly.[5]

The Tympanic diaphragm divides the Epitympanum into upper and lower units, while the top unit is further split into smaller Anterior and larger Posterior Attic or Epitympanum by a vertical fold called the "Superior malleal fold".[6]

The anterior epitympanum is divided into two spaces, anterior epitympanic recess and anterior malleal space by a bony crest called cog, which is considered the medial continuation of the transverse crest of the tegmen tympani. The anterior epitympanic recess (AER) is a small space which lies superior to cochleariformis process and anterosuperior to the malleal head.

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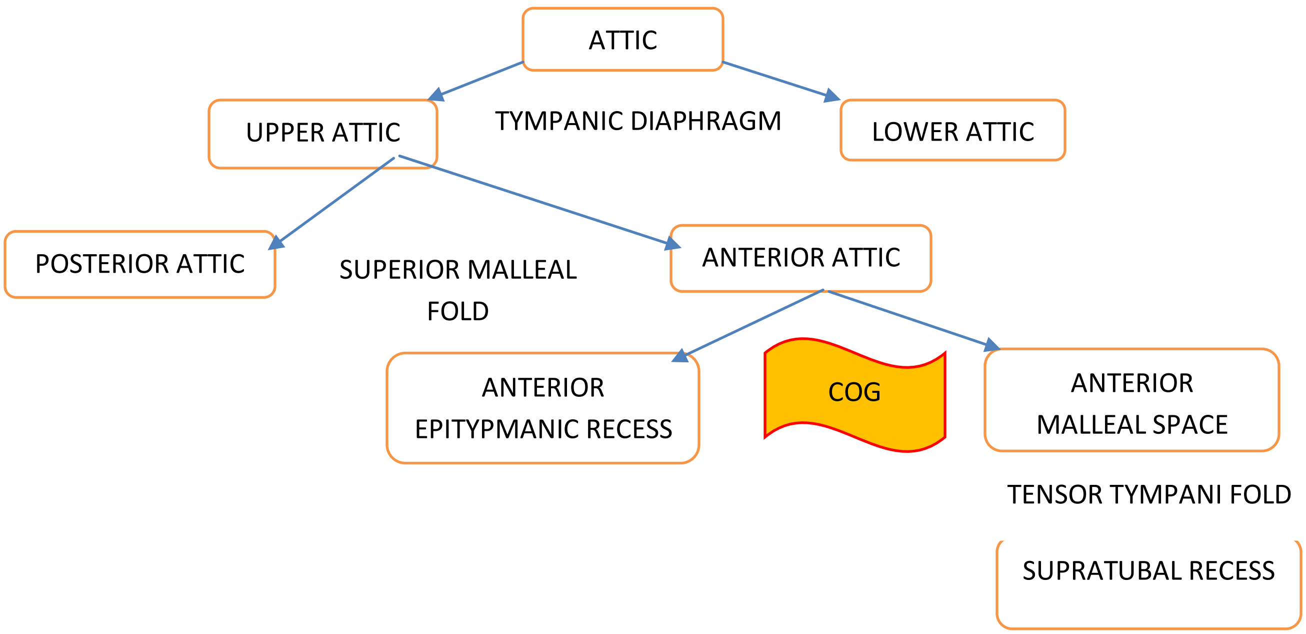

W. House was the first to describe Cog as a bony crest lying anterior to the head of the malleus, representing an embryologic remnant of the fusion plane between saccus anticus and medius, separating the anterior epitympanic space from the posterior epitympanic space. This anatomical structure has been referred to as an important landmark by different surgeons for identifying the tympanic part of the facial nerve during microscopic transmastoid approach.[1]

The cog serves as a prominent landmark for cochleariformis process which lies immediately anterior to the tympanic segment of facial nerve. The lower edge of cog divides the facial nerve into upper and lower tympanic segment, located at roughly the same level as the cochleariformis process and the lower edge also locates the geniculate ganglion, as it also lies anterior to it, signifying the junction between geniculate ganglion and labyrinthine segment of Facial nerve.[7]

It also serves as a useful landmark for determining the anatomical landmark of anterior margin of horizontal semicircular canal and the vestibule.[8]

The otologic surgeon's greatest worry during micro ear surgery is to injure these vital structures like the facial nerve, semicircular canal and the vestibule, not only because of the cosmetic and functional repercussions but also because of the potential medicolegal implications. To avoid this, thorough knowledge of the anatomical landmarks surrounding this critical structure is required.[9]

Another point of clinico-anatomical significance is that, a fully developed cog is associated with the embryological development of a type of isthmus that provides a pathway for aeration via anterior and posterior isthmic pathways, whereas an incompletely developed cog is associated with a short or absent isthmus, which results in poor attic ventilation and result in a higher incidence of cholesteatoma. Thus, the type "cog" carries important pathological concerns.[10]

In our study, the structures present in the anterior epitympanic recess (AER) were visualized with the introduction of an angled endoscope (45^0) through a trans-canal approach. A wide view of the floor of the AER was obtained, cochleariform process and inferior edge of the tensor fold were observed without drilling any bone from the epitympanum and without disturbing the ossicular chain. In some specimens, the anterior portion of the scutum was drilled under endoscopic control, the incudo-malleolar joint and the AER was visualized. We used this approach to have a wide exposure of the cog, and the lower edge of cog.

In terms of presentation, we found that cog was a bony structure in 28 out of 31 specimens (90.32%) and pneumatized in 3 specimens (9.67 %). The cog reached up to the cochleariformis process in 12 of the

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31 specimens (38.70%), whereas in rest 19 (61.29%), it extended inferiorly, reaching just short of the cochleariformis process. Cholesteatoma debris was detected in five of the specimens where Cog extended up to the cochleariformis process. Previous studies conducted on CT scans, analyzed the co-relation between cog morphology and ventilation showed that the "pyramid type" was the commonest in patients diagnosed with cholesteatoma while the "plate" type was the commonest in patients with non-cholesteatomatous csom.[11]

In majority of temporal bones dissected, cog was found to be coronal in Orientation in 23 specimens (74.19%) and in rest 8 (25.80%), it was obliquely placed. All the 5 specimens with cholesteatoma debris had coronally placed cog, so we are of the opinion that orientation of cog has no effect on predisposition to develop cholesteatoma in the anterior epitympanic recess, as would otherwise be expected. As shown by Lee et al, the development of chronic otitis media is likely related to morphological types of the "cog" to a certain degree and these structural variations of the anterior epitympanic recess must be kept in mind during the surgical management of this space.[12]

Other clinical relevance of cog which we can draw from this study, other than being an important landmark to avoid injuries to the vital structures like facial nerve, the horizontal semi-circular canal and vestibule during surgery, is the accessibility to certain areas in epitympanum after its removal. The clearance of disease from supra-labyrinthine air cells during a canal wall down mastoidectomy mandates reduction of cog. Similarly, clearance of cholesteatoma debris present in supra-tubal recess can be achieved by drilling out the cog. Also, to achieve a sufficient ventilation pathway from the eustachian tube to the epitympanum, removal of cog and tensor tympani is carried out.

Nevertheless, we emphasize that, in order to improve surgical skills, every surgeon should pay greater attention to the delicate anatomy and acquaint themselves with it by dissecting temporal bone during their training period.

Conclusions:

This study not only establishes the cog as an important landmark but also highlights its other clinical relevance in terms of the etiopathogenesis, progression and management of the disease in epitympanum. We conclude that this study will be useful, especially for the newcomers in the field of otology to better understand the intricate anatomy and pathology of the epitympanic region with respect to cog.

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Image 1: Postero-lateral view of Attic showing: - 1: COG; 2: Malleus; 3: Incus; and 4: Eustachian tube

Image 2: Image showing, 1: COG; 2: Reflected Malleus; 3: Incudo-stapedial Joint; 4: Cocleariformis Process; and 5: Supratubal recess

Image 3: Reflection of malleus and chorda tympani to better visualize, 1: COG and 2: Supratubal recess

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Image 4: A ball probe being used to assess the depth of Supratubal recess.

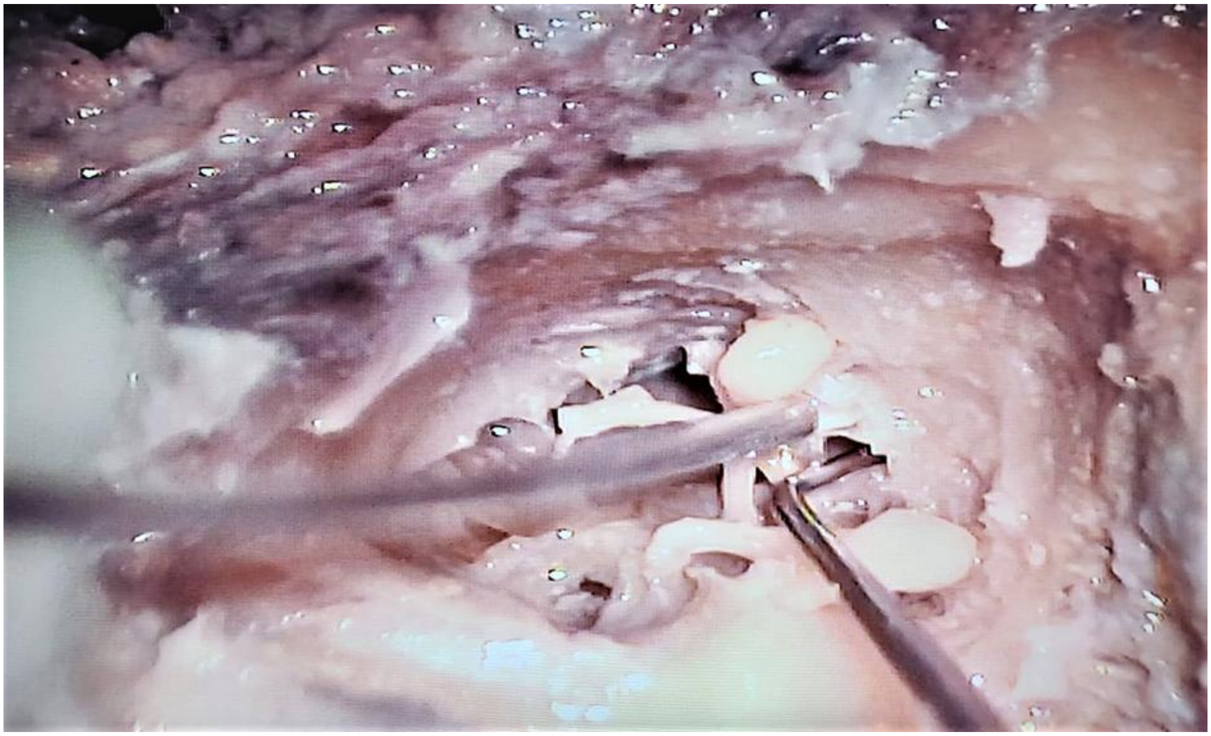


Image 5: Drill out of COG carried out to better visualize Supratubal recess

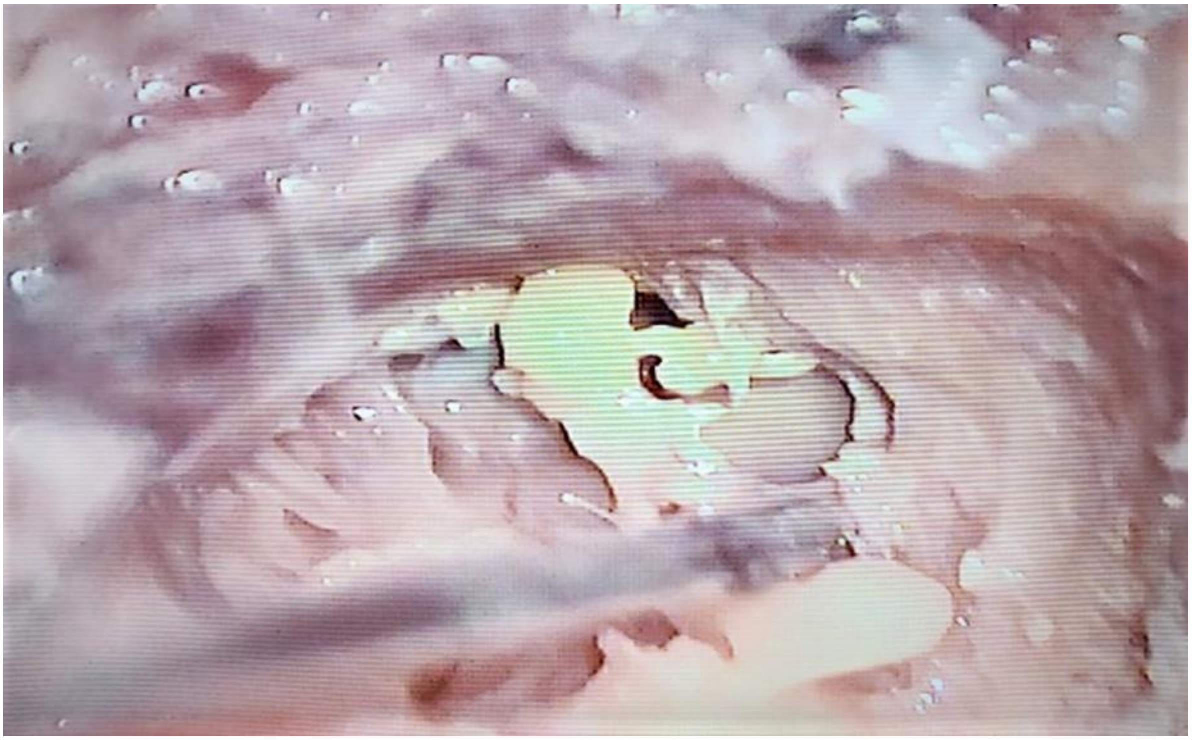
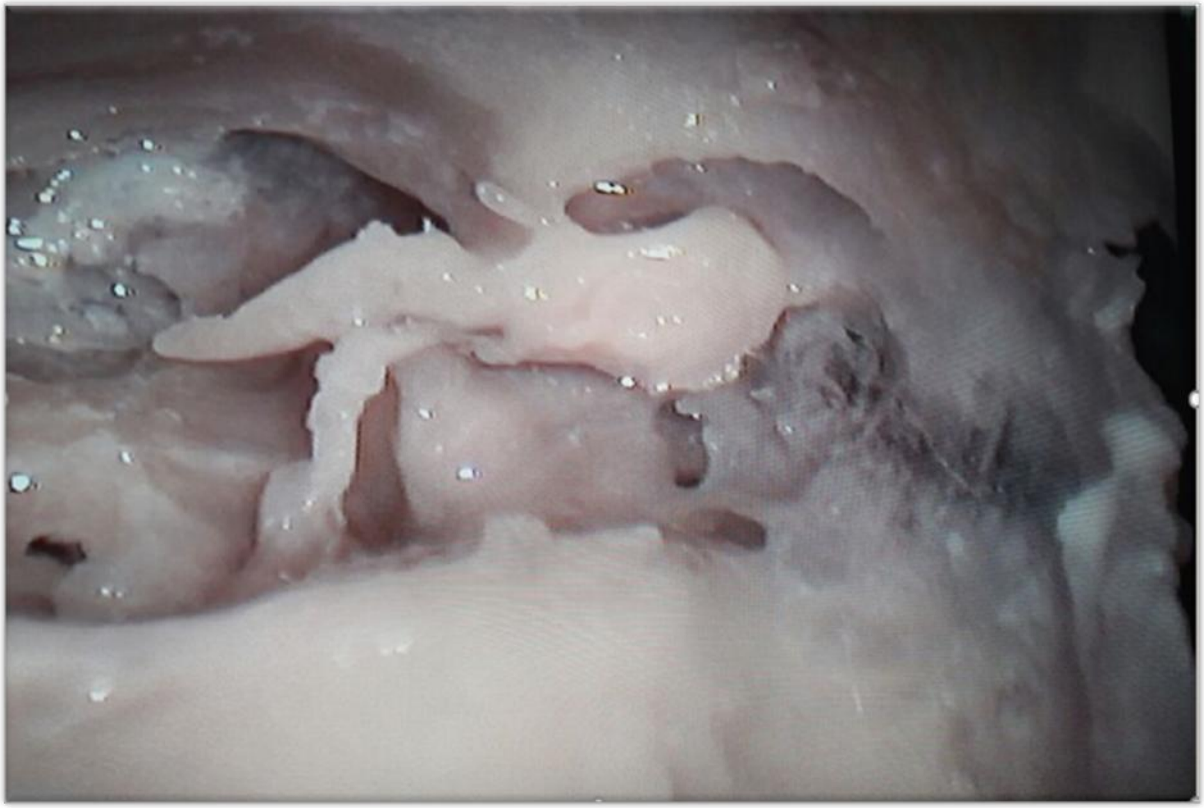


Image 6: Image showing well pneumatized COG(after retracting the malleus) in one of the specimen



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