

CT Assessment of Anterior Ethmoidal Canal Dehiscence; An Interobserver Agreement Study and Review of Literature

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Disclosure of Conflict of Interest

No Disclosures

Introduction

- Functional endoscopic sinus surgery (FESS) is a common treatment option for patients with chronic rhinosinusitis , neoplastic processes, skull base and orbital lesions.
- Rate of complications associated with FESS is about 5,6% to 22% including CSF leak, optic nerve injury, oculomotor deficits, nasolacrimal duct injury, anosmia and perioperative hemorrhage.
- The anterior ethmoidal artery can be injured causing significant bleeding at surgery and periorbital or intraorbital hematoma.

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2. Labruzzo SV, Aygun N, Zinreich SJ. Imaging of the paranasal sinuses: Mitigation, identification, and workup of functional endoscopic surgery complications. *Otolaryngol Clin North Am* 2015;48:805-15.

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Normal and Variant Anatomy of the Anterior Ethmoidal Canal

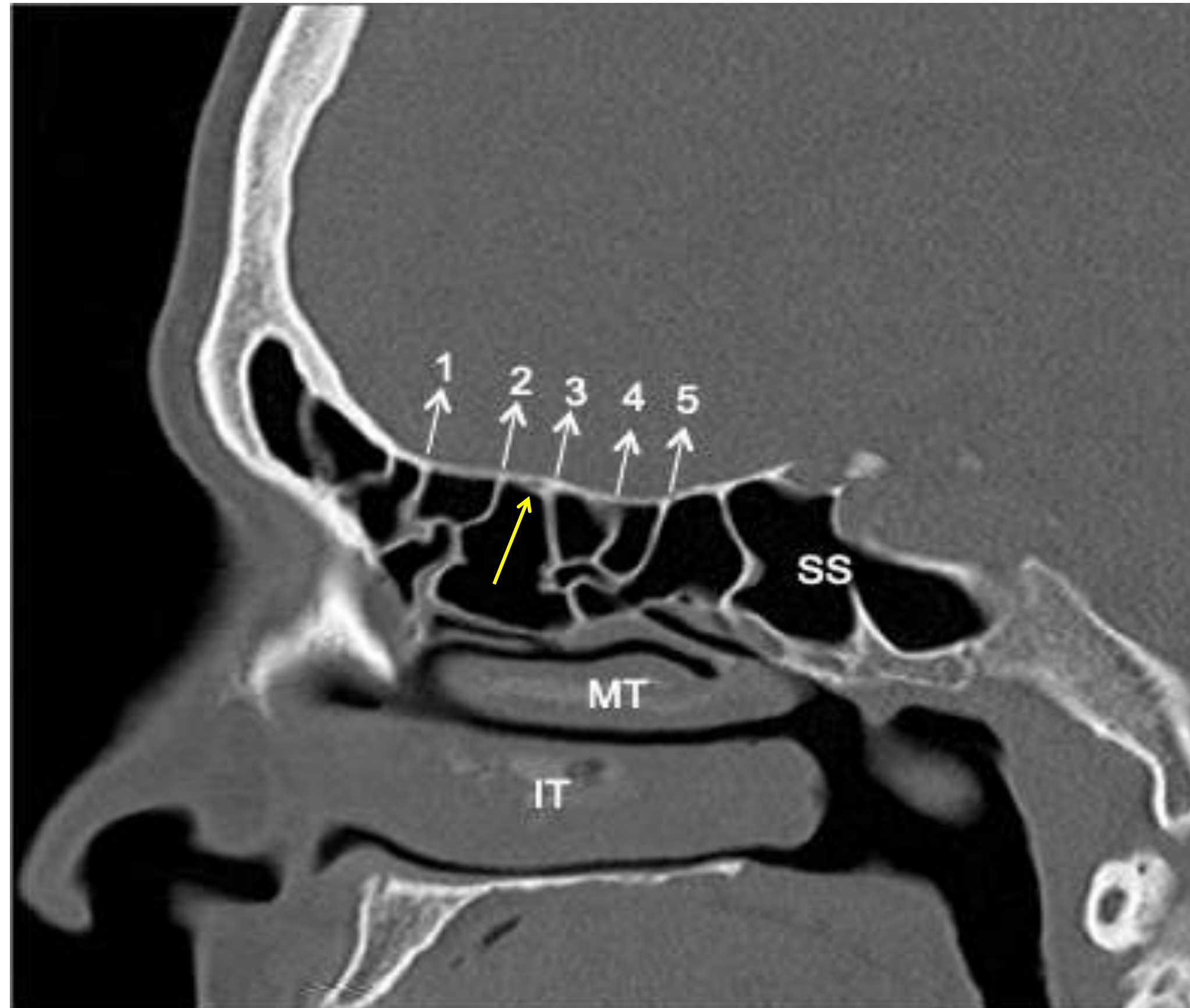
- The anterior ethmoidal artery (AEA) is a branch of the ophthalmic artery
- Supplies the anterior ethmoidal cells and the frontal sinus
- The AEA is divided into 3 segments: intraorbital, ethmoidal and intracranial
- Multiple dissection studies showed that the anterior ethmoidal artery is located between the second and the third lamella in most of the cases

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Anatomic variations of the anterior ethmoidal artery are wide and it is essential to be aware of these variants in the surgical field.

Normal and Variant Anatomy of the Anterior Ethmoidal Canal



Sagittal CT image showing lamellar anatomy. 1: uncinete process, 2: Bulla ethmoidalis, 3: basal lamella, 4: lamella of the superior turbinate, 5: lamella of the supreme turbinate. SS: sphenoid sinus, MT: middle turbinate, IT: inferior turbinate. Notice the AEC between the second and third lamella (yellow arrow)

Normal and Variant Anatomy of the Anterior Ethmoidal Canal

- The anterior ethmoidal canal (AEC) which houses the AEA, is usually embedded in the ethmoidal roof
- Anatomical variations of the AEC based on its relation to the skull base:
 - Grade I AEC within the ethmoidal roof
 - Grade II AEC under the roof and considered as prominent
 - Grade III AEC distant from the ethmoidal roof

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In cases of prominence of the AEC or when it is below the roof the risk of AEA injury increases since the anterior ethmoidal roof is the landmark and outer limit for endonasal surgery

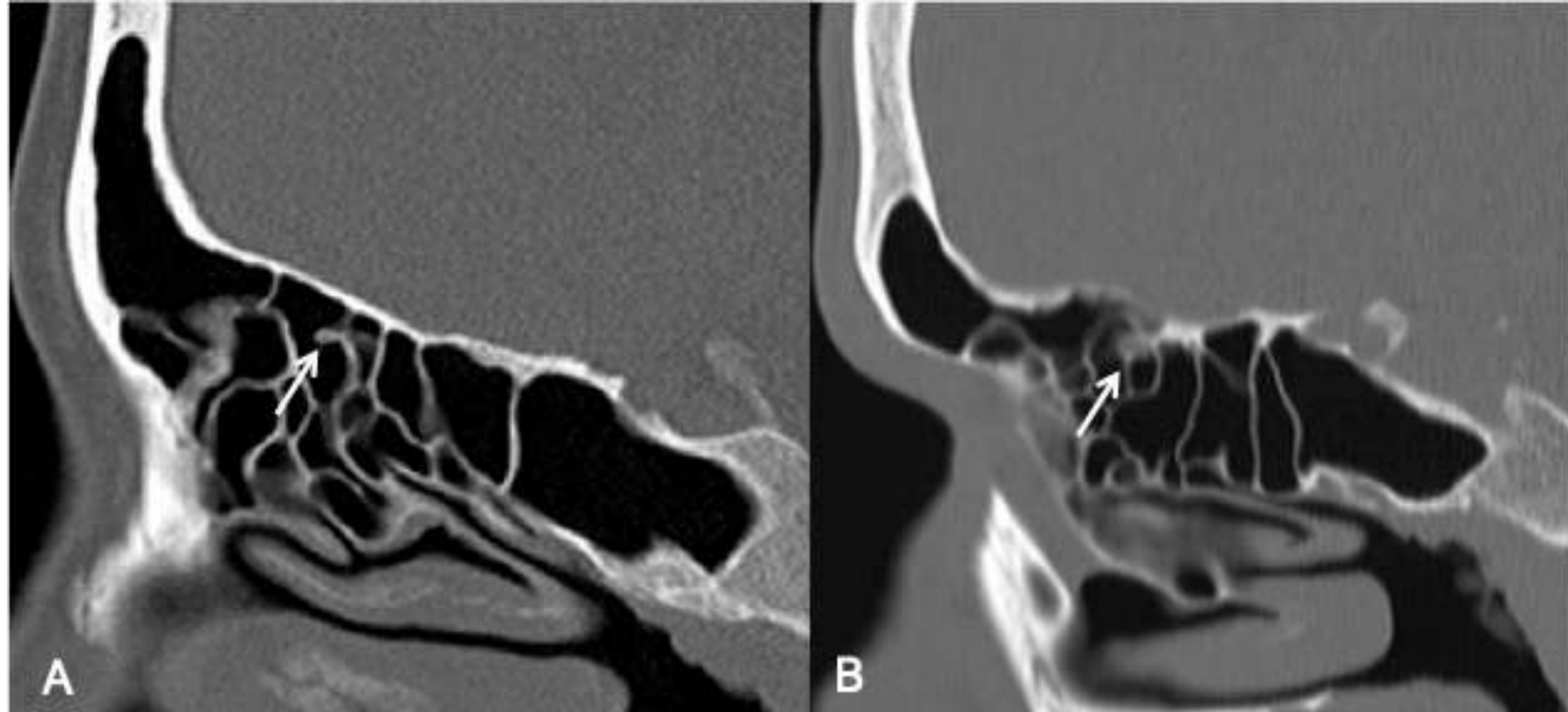
Anatomical variations of the AEC based on its relation to the skull base



Sagittal CT images showing anatomical variations of the AEC. (A) Grade I: within the roof , (B) Grade II: under de roof, considered as prominent, (C) Grade III: distant from the ethmoidal roof (arrows).

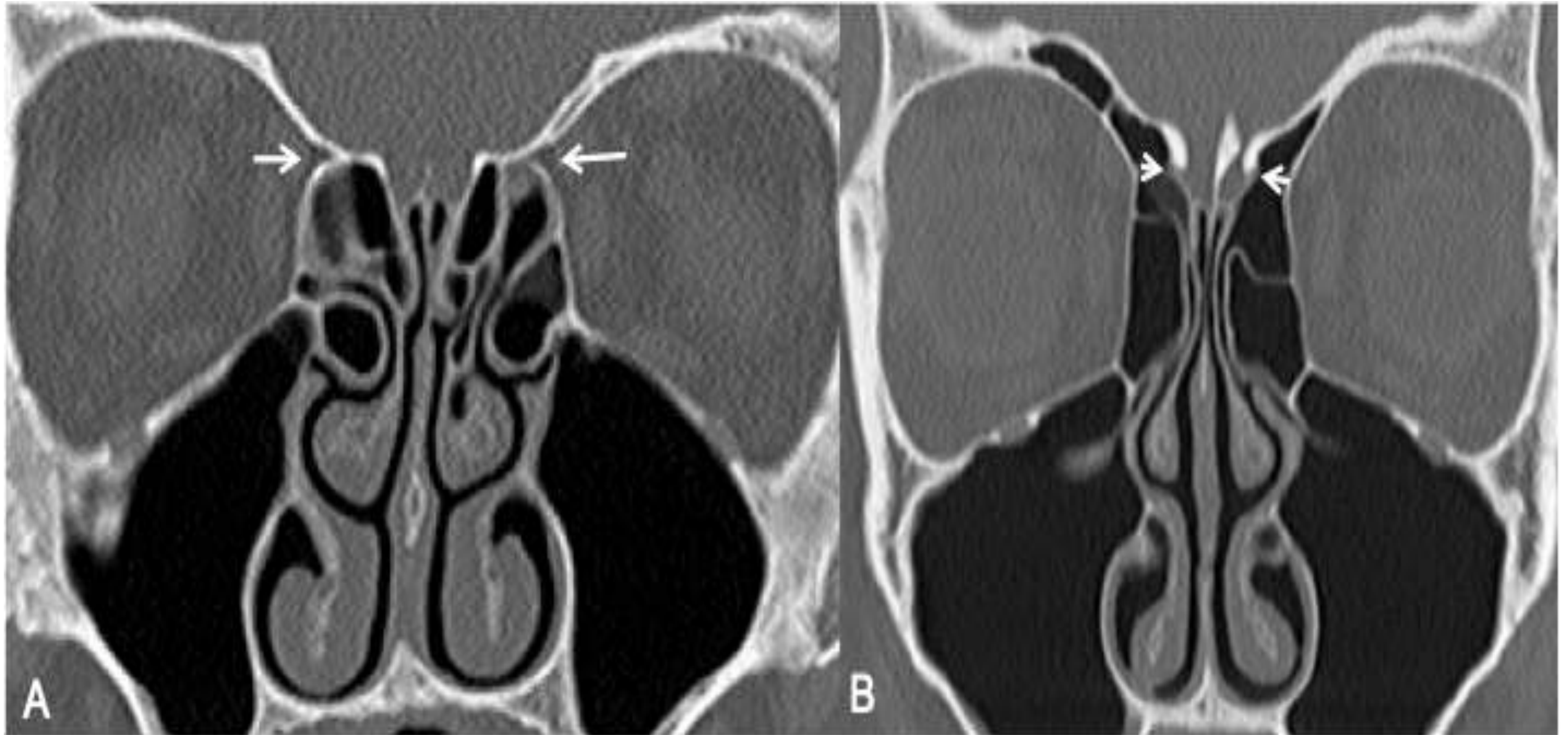
Normal and Variant Anatomy of the Anterior Ethmoidal Canal

- The normal bony covering of the AEC may be absent inferiorly and the artery is suspended in a mucous membrane mesentery which increases the risk of injury during surgery.
- The prevalence of dehiscence of the AEC varies significantly in the literature ranging from 6% to 66%



Sagittal CT images showing: (A) normal bony covering of the AEC, (B) AEC dehiscence (arrows)

Anatomical landmarks for locating the AEA on coronal CT



Coronal CT images showing: (A) bony notch on the medial wall of the orbit, (B) Anterior ethmoidal groove on the lateral walls of the olfactory fossae (arrows).

Introduction

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- The CT ability to correctly identify dehiscence has not been widely evaluated with one study suggesting it is poor

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The aim of this study is to evaluate the interobserver agreement in the CT assessment of AEC dehiscence.

Materials and Methods

- A retrospective review of consecutive CT scans of the paranasal sinuses (PNS) on PACS between January 1, 2012 and December 31, 2012 was conducted.
- Cases with the AEC in the ethmoidal roof/skull base and postoperative cases with alteration of the anatomy or pathology causing bony destruction were excluded.
- Two neuroradiologists with more than 10 years of experience, separately read all the cases after an initial training session.
- Each neuroradiologist assessed the presence of AEC dehiscence, the presence of PNS opacification and the perceived best CT plane to evaluate the AEC.
- Statistical analysis included descriptive analysis as well as interobserver agreement (Kappa coefficient), with k values of 0-0.2 indicating poor agreement, 0,21-0.40 fair agreement, 0,41 – 0,60 moderate agreement, 0,61- 0,80 substantial agreement and 0,81 – 1.0 almost perfect agreement.

Results

- 1008 CT scans of the paranasal sinuses were performed.
- 107 patients were excluded:
 - Incomplete imaging [absent sagittal or coronal reformats] (n=56)
 - Trauma (n=1)
 - Tumor (n= 2)
 - Motion artifact (n=4)
 - Prior surgery (n=44)
- 901 patients formed the basis of the current study.

Results

	Skull base (Grade I - II)	Below the skull base (Grade III)
Anterior etmoidal canal	76.8% (n= 692)	23,1% (n= 209)

	Below Skull base (Bilaterally)	Below Skull base (Only left side)	Below Sull base (Only right side)
Anterior etmoidal canal (Slice thickness 2mm) 199 cases	11,4% (n= 102)	5,9 % (n= 53)	4,8% (n= 44)

Results

	Reader 1	Reader 2
Dehiscence of the AEC	13,2% (n=41)	7,3% (n=22)
Opacification of the Paranasal Sinuses	19,6% (n=59)	25,5% (n=77)
Best Plane to assess AEC	Coronal Plane 53,8% (n=162)	Sagittal Plane 787,7% (n=234)

Results

- Interobserver agreement:
- Identification of the AEC dehiscence:
- Identification of the AEC dehiscence in cases with PNS opacification:

$k = 0,246$
Fair

$k = 0,754,$
Substantial

Discussion

- Reported incidence of AEC dehiscence is variable in the literature ranging between 6% to 67%
- Discrepancies between the prior studies and our results can be explained by:
 1. Differences in race or due to the points where the nerves pass through the canal and cause focal bony dehiscence .
 2. Dissection studies had the advantage of magnification provided by microscopes or endoscopes and subsequently higher sensitivity.
 3. Differences in study methodologies (slice thickness and plane used for assessment of the AEC)

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Kainz J, Stammberger H. The roof of the anterior ethmoid: A locus minoris resistentiae in the skull base. *Laryngol Rhinol Otol* 1988;67:142-9.

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Discussion

- PNS opacification improves the delineation of the AEC bony contours and facilitates assessment for its dehiscence compared to AEC in well aerated ethmoid air cells.
- The AEC can be located below the skull base unilaterally (slightly more on the left(5,9%) compared to the right(4,8%)) which was not clearly described before. This finding highlights the importance of scrutinizing each side separately when required to assess the location of the AEC and its dehiscence

Study Limitations

1. It is a retrospective study of patients from a single hospital.
2. We did not correlate with intraoperative findings for patients who proceeded to surgery and hence, our results regarding cannot be used the diagnostic accuracy of CT in identification of AEC dehiscence.
3. We had to exclude some of the patients with AEC below the skull base due to slice thickness used for scanning.

Conclusions

1. Awareness of the anatomical variants and the radiological landmarks of the AEA are important parameters in the assessment of the preoperative CT.
2. CT could still add valuable information regarding the AEC dehiscence in the preoperative setting in patients with ethmoid air cells opacification.
3. Future studies are required to compare the diagnostic accuracy of CT assessment versus direct intraoperative visualization to identify the dehiscence of the anterior ethmoidal canal.

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