

Original Research Article

Study of variants of anterior ethmoidal artery on computed tomography of paranasal sinuses

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Received: 20 November 2018

Revised: 06 December 2018

Accepted: 08 December 2018

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ABSTRACT

Background: The anterior ethmoidal artery (AEA) is an anatomical landmark, its position is important for recognizing structures of difficult access (frontal sinus) and to define skull base in surgery. Additionally, visualizing this artery makes it possible to identify and treat causes of severe epistaxis. The aims and objectives of the study were to determine the reliability of identification of the AEA on the coronal CT scan, to study the variability in the pneumatization of the suprabullar recess and the course of the AEA and to determine whether a correlation exists between the pneumatization of the suprabullar recess and the distance of the AEA from the base skull.

Methods: This study conducted among 200 Patients attending to ENT OPD, Yashoda hospital, Secunderabad with history of headache, nose block who underwent CT-PNS. Patients with age above 18 years without any congenital anomalies of face, without opacification in frontal recess or anterior ethmoidal cells, without nasal surgeries or trauma were included in the present study. All the 200 CT-PNS were studied in detail by using PACS and DICOM software.

Results: In this study AEA was present in 100% of cases on both sides. In this study AEA was seen in skull base in 50.75% of cases, among this 51% was on right side, remaining was on left side.

Conclusions: CT-PNS coronal sections are helpful in assessment of AEA position pre-operatively. AEF and AES act as important landmarks for the identification of AEA in CT-PNS.

Keywords: Anterior ethmoidal artery, Variations, CT PNS

INTRODUCTION

The anterior ethmoidal artery (AEA) is an anatomical landmark, its position is important for recognizing structures of difficult access (frontal sinus) and to define skull base in surgery.¹⁻⁴ Additionally, visualizing this artery makes it possible to identify and treat causes of severe epistaxis.⁵ The possibility to obtain, with preoperative imaging techniques, information about paranasal sinus (PNS) development and pneumatization variants, as well as anatomical variants of vessel course and its relationship with adjacent rhino ethmoidal structures for pre-surgical planning, may be very

important to improve safety and results of rhinosinus endoscopic surgery.

The AEA originates from the distal ophthalmic artery in the anterior third part of the orbital cavity. It then crosses the medial orbital wall passing through the anterior ethmoidal foramen so travelling in the anterior ethmoid. The vessel often passes through a thin-walled bony canal or in the depth of an ethmoidal lamella. Less frequently AEA courses outside the bony canal (unprotected AEA). On the axial plane the AEA course inside the ethmoid is nearly constantly characterized by a curve with the anterior concavity. After crossing the ascending ethmoidal lamella, the vessel course becomes endocranial

with anterior direction, parallel to the laminacribrosa, in which it introduces several collateral vessels. AEA is characterized by three segments: a very brief intraorbital segment, the second intraethmoidal and the third endocranial segment. Obviously, the intraethmoidal segment is the most vulnerable during rhinosinusal surgery

Aims and objectives

We undertook this study to determine the reliability of identification of the AEA on the coronal CT scan, to study the variability in the pneumatization of the suprabullar recess and the course of the AEA and to determine whether a correlation exists between the pneumatization of the suprabullar recess and the distance of the AEA from the base skull.

METHODS

The study was conducted among 200 patients who attended to ENT OPD of the Yashoda hospital, Secunderabad from 2015 to 2017 over a period of 2 years. A detailed history was taken from all the patients with symptoms like nose block, headache, frequent colds, etc.. After clinical examination, CT-PNS was advised and coronal sections of 3mm size were studied in detail. PACS software used for detail study of CT-PNS including evaluation of AEA.

Patients with age above 18 years without any congenital anomalies of face, without opacification in frontal recess or anterior ethmoidal cells, without previous nasal surgeries or trauma were included in the present study. Patients below 18yrs of age with either fungal sinusitis or polyps or haziness of the frontal and ethmoidal sinuses were excluded from the study. All the 200 CT-PNS i.e. 400 sides were studied in detail by using PACS and DICOM software. AEA was evaluated in all scans by using landmarks like AEF, superior oblique muscle, suprabullar cells and suprabullar recess, anterior ethmoidal sulcus (AES) and depth of the olfactory fossa.

RESULTS

In this study AEA was present in 100% of cases, on both sides. AES was seen in 94.5% on both sides. AEF and AES are important landmarks for the identification of AEA. Based on distance of AEA canal from skull base and its length from AEF to AES is calculated and classified as Skull base -AEA canal distance from skull base is <2.5 mm, Short mesentery - AEA canal distance from skull base between 2.5 to 5 mm and length of AEA canal from AEF to AES <10 mm, long mesentery- AEA distance from skull base >5 mm and length of AEA canal from AEF to AES >10 mm. In this study AEA was seen in skull base in 50.75% of cases (203/400), on right side it was 51% (102/200) whereas on left side it was 50.5% (101/200). Short mesentery was seen in 39.25% cases (157/400), on right side it was 38% (76/200) whereas on

left side it was 40.5% (81/200). Long mesentery was seen in 10% cases (40/400), on right side it was 11% (22/200) and on left side 9% (18/200) with p value 0.7542. AEA seen in skull base was 48.4% short mesentery was 34% and long mesentery was 17.5% (Table 1).

Table 1: percentage of showing position of anterior ethmoidal artery on both sides in study group.

AEA	Right (%)	Left (%)
Short mesentery	76 (38)	81 (40.5)
Skull base	102 (51)	101 (50.5)
Long mesentery	22 (11)	18 (9)

Pneumatization of ethmoid labyrinth and presence of supraorbital and suprabullar cells significantly impacts on the position of AEA. Supraorbital ethmoid cell (SOEC) defined by Alyvea as a cell produced by superolateral pneumatization of the orbital plate of the frontal bone, immediately posterior and lateral to frontal ostium with lateral pneumatization beyond the plane of the most medial portion of lamina papyraria. SOEC acts a landmark for identification of AEA which lies on posterior wall of SOEC.

In this study suprabullar cell (SBC) present in 44.75% (179/400) cases, on right side it was 45% (90/200) whereas on left side it was 44.5% (89/200); in such case AEA was in mesentery position in 98.8% (177/179), on right side it was 97.7% (89/90) and on left side 100% (89/89) (Table 2).

Table 2: Showing suprabullar cells correlation with AEA position.

Side	Right (%)	Left (%)
SBC	90	89
AEA (mesentery)	88 (97.77)	89 (100)
AEA (skull base)	2 (2.22)	0

Pneumatization of frontal sinus also impacts on position of the AEA. In rudimentary frontal sinus cases AEA was in skull base in 100% of cases (Table 3).

Table 3: Rudimentary frontal sinus, AEA position skull base.

Side	Right (%)	Left (%)
AEA (skull base)	10 (100)	7 (100)
Frontal sinus (rudimentary)	10 (100)	7 (100)

Mesentery position of AEA will also depend on lateral lamella of cribriform plate and depth of the olfactory fossa. AEA was in mesentery position in 61.42% when olfactory fossa was type 2, whereas it was 38.57% when type 1 olfactory fossa (Figure 1 and 2).

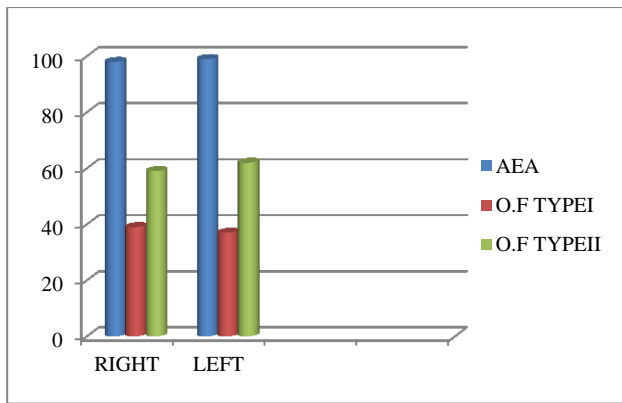


Figure 1: Showing association of short mesentery AEA in different types of olfactory fossa on both sides.

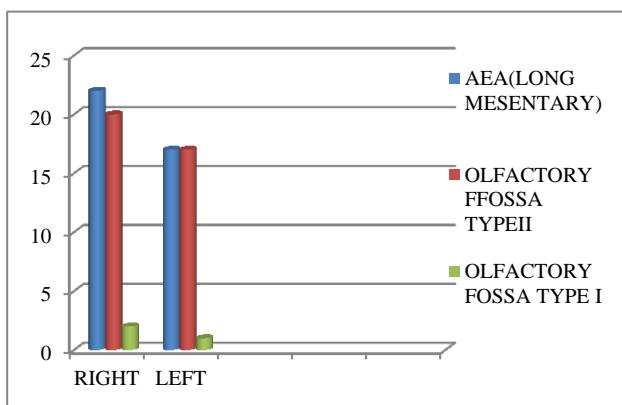


Figure 2: Showing association of long mesentery AEA in different types of olfactory fossa on both sides.

When AEA was in mesentery bony canal was absent in 11.67%. Bony canal was absent in 17.5% cases of long mesentery which put the artery at more risk of injury during surgery (Table 4).

Table 4: showing bony canal comparison with mesentery.

Side	AEA (mesentery)	Bony canal (present) (%)	Bony canal (absent) (%)
Right	98	89 (90.8)	9 (9.18)
Left	99	85 (85.85)	14 (14.14)
Total	197	174 (88.32)	23 (11.67)

DISCUSSION

AEA is particularly one of the most notable endoscopic reference, marks posterior limit of the frontal recess. Similarly in extending approach, its identification in the fronto ethmoidal suture marks the limit of the anterior skull base. In this study total 200 CT-SCAN i.e. 400 sides has been selected after excluding the exclusion criteria. By using somantrans definition dual source- 64 spiral CT-scan with 0.6x64 acquisition with 0.3 rotations per seconds speed and 120 kv energy, PNS coronal sections

of 3mm taken. In total 200 CT-PNS or 400 sides majority fall between 20-39 years of age i.e. 69% and males were 54% whereas females were 46%.

Landmarks used for identification of AEA are Orbital beak at the junction of superior and medial orbital wall, which also called as AEF, Superior oblique muscle, Vertical lamella of cribriform plate, where the AEA enters anterior cranial fossa, which also called as AES. Orbital beak is the triangular part of bone seen at junction of superior and medial orbital wall, which is presented even in extended disease of the sinus. Pyramid shaped notch in the medial wall of the orbit, which corresponds to the exit of the artery between superior oblique and medial rectus muscle which is the most constant anatomical reference for location in the CT scan.^{7,8} After exiting from the AEF, AEA courses obliquely in the ethmoid labyrinth from lateral to medial and anterior to posterior direction, and lies 1-2 mm posterior to the highest point of the ethmoidal bulla anterior face or it may lie on the posterior wall of the frontal recess, which is correlated in this study.^{2,9-12}

In this study AEA was present in 100% of cases, according to Chung et al CT cadaver study AEA found in 95%, according to Souza et al it was found in 97% cases, whereas according to Kirchner et al.^{8,13,14} AEA was absent 7% cases, according to Araujo et al AEA absent in 8% and according to Han et al AEA was absent in 4% which is closely relating to this study.^{6,15} Presence of AEF was seen in 100% of cases on both sides which is correlating with the study Souza et al.⁸ AES was seen in 94.5% on both sides which also correlates with Souza et al where AES was present in 95% of cases.⁸ According to radiological anatomy of AEA and FESS AEF was present in 95%.⁶ Gotwald et al and Souza et al also took AEF and AES as landmark for the identification of AEA.^{7,8}

In this study AEA was seen in skull base in 50.75% of cases (203/400), on right side it was 51% (102/200) whereas on left side it was 50.5% (101/200). Short mesentery was seen in 39.25% cases (157/400), on right side it was 38% (76/200) whereas on left side it was 40.5% (81/200). Long mesentery was seen in 10% cases (40/400), on right side it was 11% (22/200) and on left side 9% (18/200) with p value 0.7542 which is nearer to the Joshi et al. study, where AEA was seen in skull base 48.4%, short mesentery 34%, and long mesentery 17.5%.^{16,17}

Pneumatization of ethmoid labyrinth and presence of supraorbital, suprabullar cells significantly impacts on the position of AEA. In this study SBC's were present in 44.75% (179/400) cases, on right side it was 45% (90/200) whereas on left side it was 44.5% (89/200); in such case AEA was in mesentery position in 98.8% (177/179), on right side it was 97.7% (89/90) and on left side 100% (89/89). These results are correlating with the study of radiological correlation between AEA and SOEC where 86% of the cases were in mesentery when

SBC are present.¹⁵ According to Simmens et al, degree of pneumatization of the ethmoid cells and the presence or absence of supraorbital cells are predictive for AEA localization in relation to the level of skull base.⁴ Pneumatization of frontal sinus also impacts on the position of the AEA. In rudimentary frontal sinus cases AEA was in skull base in 100% of cases, on right side (10/10) and on left side (7/7). Mesentery position of AEA will also depends on lateral lamella of cribriform plate and depth of the olfactory fossa.⁴ AEA was in mesentery position in 61.42% when olfactory fossa was type2, whereas it was 38.57% when type1 olfactory fossa was observed. Bony canal was absent in 17.5% cases when AEA was in long mesentery position. In this scenario chances of injury to AEA during surgery is more. AEA was in mesentery position in 62.5% of cases when inter frontal cell was present. Position of AEA also depends on the uncinata upper attachment. In this study results are like AEA was in skull base in 100% of cases when upper attachment of uncinata to skull base. AEA was in mesentery in 75% of cases when upper attachment of uncinata to the lamina papyracia. In 57% of cases AEA was in mesentery position when upper attachment of uncinata to middle turbinate. Position of AEA also depends on the presence of infundibular cells. AEA was in mesentery position in 100% of cases (40/40) in the presence of infundibular cells. AEA was in mesentery position when posterior ethmoids were more pneumatized.

CONCLUSION

CT-PNS coronal sections are helpful in assessment of AEA position pre-operatively. Position of AEA depends on ethmoid labyrinth pneumatization, suprabullar cells and suprabullar recess, upper attachment of uncinata process, olfactory fossa depth, pneumatization of frontal sinus, posterior ethmoids and presence of infundibular cells.

AEA in long mesentery with absent bony canal can be assessed preoperatively on CT PNS. In this scenario there is more chances of injury to vessel during surgery, hence care must be taken to prevent complications like orbital haematoma and haemorrhage.

Recommendations

AEA position must be looked for in all CT-PNS pre-operatively to prevent intra-operative complications. Care must be taken during surgery, when AEA was in long mesentery position with absent bony canal as per CT-PNS.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Amarnath SB, Kumar PS. Study of variants of anterior ethmoidal artery on computed tomography of paranasal sinuses. *Int J Otorhinolaryngol Head Neck Surg* 2019;5:19-23.