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Radio Anatomical Analysis of Positional Relation between Anterior Ethmoid Artery Canal and Ethmoid Skull Base in Correlation with Olfactory Fossa

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Original Research Article

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Abstract: ***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. The anterior ethmoidal artery crosses three cavities: the orbit, the ethmoid labyrinth and the anterior fossa of the skull. The aims and objectives of the study are to determine the course of the AEA and the distance of the AEA from the base skull. ***Material and Methods:*** A surveying radiological study was carried out on 100 coronal CT images from subjects who were exposed to paranasal CT imaging during a period April-July 2018 in a tertiary hospital. All CT images, along with indication of sinusitis were encompassed in the examination. The elimination being changed skull base anatomy due to earlier surgical interference, injury or tumour and age <18 years. ***Result:*** Among the coronal CT images analyzed, the male and female were noted to be 60 and 20 respectively. Out of 160 sides, AEA was identified in all the images studied (100%). The AEA was found below SB in 134 out of 160 (83.8%). On measuring the distance between the AEA and SB majority belonged to Group A (74 out of 134) in comparison to Group B (40 out of 134) and Group C (20 out of 134). The mean distance was found to be 1.43 mm, 3.8 mm, 5.72 mm in Group A, Group B and Group C respectively. The overall mean distance between the AEA and the SB was 3.65 mm. ***Discussion:*** The AEA is an anato-radiologic keystone for paranasal sinus and anterior skull base endoscopic operations. The presence of AEA in all of the pictures examined in this investigation is consistent with the reported range of 92-100 percent. In the ethmoidal air sinus, AEA was found to have a varied path. ***Conclusion:*** Due to differences in the length of the lateral lamella of the cribriform fossa, the distance between AEA and SB differs. The structure of the olfactory fossa varies. Despite the statistical limitations, the positional association between AEA and the depth of the olfactory fossa is noteworthy.
Keywords: Anterior ethmoid artery, Skull base, Lateral lamella, Olfactory fossa.

INTRODUCTION

The anterior ethmoidal artery (AEA) is an anatomical landmark; its position is important for recognizing structures of difficult access (frontal sinus) and to express skull base in surgery. Additionally, it is possible to diagnose and treat the causes of severe epistaxis by imaging this artery. The study's objectives and goals were to establish the efficiency of identifying the AEA on a coronal CT scan, as well as to investigate the variability in the pneumatisation of the suprabullar recess and the route of the AEA, as well as the AEA's distance from the base skull. [1]

The anterior ethmoidal artery passes through three cavities: the orbit, the ethmoid labyrinth and the anterior fossa of the skull. In enters the olfactory fossa through the lateral lamella of the cribiform plate along the so-called anterior ethmoidal sulcus, which is the point of greatest frailty of the whole anterior skull base. At this point the bone is extremely thin, and is considered as a high-risk area in nasal endoscopic surgery. [2,3] In its course through the ethmoid labyrinth, the position of the anterior ethmoidal artery relative to the ethmoidal roof is very variable; the artery thus becomes vulnerable to injury during surgical procedures. This artery irrigates the anterior ethmoidal cells and the frontal sinus; it also gives rise to the meningeal vessels in its course along the olfactory fossa, and also descends to the nasal fossa to irrigate the anterior thirds of the nasal septum and the lateral wall of the nose.

The orbit, the ethmoid labyrinth, and the anterior fossa of the skull are the 3 paths through which the anterior ethmoidal artery passes. The olfactory fossa is accessed through the lateral lamella of the cribiform plate, which runs along the so-called anterior ethmoidal sulcus, the most fragile part of the anterior skull base. The bone is very thin at this point, making nasal endoscopic surgery a high-risk procedure. [2,3] The position of the anterior

ethmoidal artery relative to the ethmoidal roof varies greatly as it travels through the ethmoid labyrinth; as a result, the artery is prone to injury during surgeries. The anterior ethmoidal cells and frontal sinus are irrigated by this artery. It also gives rise to the meningeal vessels in its course along the olfactory fossa, and also moves down to the nasal fossa to irrigate the anterior thirds of the nasal septum and the lateral wall of the nose.

In the investigation, diagnosis, and management of ASB pathology, computed tomography (CT) and magnetic resonance imaging (MRI) with multi-planar reconstructions are essential. A thorough understanding of anatomy in this field is essential for accurate pathology interpretation and delineation. The goal of this pictorial review is to present a number of different of ASB pathology, with a focus on relevant imaging features that may affect the management of these patients for surgeons, oncologists, and interventional radiologists.

The depth of the olfactory fossa is divided into three types according to Keros' 1962 categorization: type 1, 1–3 mm, type 2, 4–7 mm, and type 3, 8–16 mm. [4] Type 3 endoscopic sinus surgery is the most threatening and essential type, with a very thin cribriform plate. [5] Following the Keros classification, several studies on the ethmoid roof and OF in various populations have been conducted over the years. [6] In addition to the Keros types and classification, the Yenigun classification is based on the anterior ethmoidal artery and ethmoid roof, with the olfactory fossa analysed as transverse. [7] As a result of this classification, the risk of injury increases as the length of the canal of the anterior ethmoidal artery and the frequency of the artery increase.

MATERIAL AND METHODS

A surveying radiological study was conducted on 80 coronal CT images from patients who were exposed to paranasal CT imaging in a tertiary care teaching hospital between April and July 2018. The examination included all CT images as well as an indication of sinusitis. The exclusion being changed skull base anatomy as a result of previous surgical intervention, injury, or tumour, and age less than 18 years. RadiAnt Dicom viewer was used to inspect the images. [8] The position of AEA in relation to SB was identified in the bone window of coronal CT scans. On each side, it was divided as at SB or below SB. the longitudinal distance from AEA to SB was evaluated separately. Depending up on the distance of AEA from SB, 3 groups were sectioned as follows: set A - < 2.5 mm, set B – 2.5 to 5 mm and set C - > 5 mm.

The deepness of the olfactory fossa was calculated with orientation to length of the lateral lamella of cribriform plate and characterized rendering to Keros categorization as Keros type I – 1to 3 mm, type II – 4 to 7 mm and type – III – 8 to 16 mm.

The information was numerically analysed utilising SPPS software system. The chi-square test was useful to relay the distance amongst AEA and SB and the deepness of olfactory fossa. P value of < 0.05 was defined as numerically noteworthy. The study was assumed after consent from official principled board. [9]

RESULT

Males recorded for 60 of the coronal CT images examined, while females recorded for 20. AEA was identified in all of the images studied out of 160 sides (100 percent). In 134 of 160 cases, the AEA was found to be below SB (83.8 percent). When the distance between the AEA and SB was measured, the majority (74 out of 134) belonged to Group A, followed by Group B (40 out of 134) and Group C. (20 out of 134). The mean distance in Groups A, B, and C was 1.43 mm, 3.8 mm, and 5.72 mm, respectively. On average, the AEA and SB were 3.65 mm apart.

CT images with AEA below the SB were frequently found to have type II Keros classification. In this study, the unobserved type was Keros type III (Table 1). AEA was found at the SB on 26 of 160 sides (16.3 percent). Kero's type III was also noted to be absent in this group (Table 1).

The P value was significant (P =.006) when the Chi-square test was used to compare the position of AEA and Keros classification (Table 1). The position of AEA below SB became more common as the height of SB raised with the Keros classification (Table 1).

when the relational distance between AEA and SB was compared to the depth of the olfactory fossa (Table 2), data revealed that Keros type II was the most common type present among all groups. The Chi-square test was used to determine the significant association between the groups, and the measured P value was greater than 0.05. This clearly indicates that the groups had a non-significant correlation.

Table 1: Keros classification distribution with AEA below and at SB

	AEA below SB	AEA at SB
Keros Type I	56 (35.0)	11 (6.88)
Keros Type II	78 (48.74)	15 (9.38)
Keros Type III	0	0

The chi-square statistic is 7.5948. The p-value is .005854. The result is significant at p < .05

Table 2: showing the relationship between the AEA-to-SB distance and the Keros classification (olfactory fossa depth)

	Keros type I	Keros Type II	Keros Type III	Total
Group A	30 (22.38)	54 (40.29)	0	84
Group B	16 (11.94)	24 (17.91)	0	40
Group C	2 (1.49)	8 (5.97)	0	10
Total	48	86	0	134

DISCUSSION

The AEA is an anato-radiologic keystone for paranasal sinus endoscopic surgeries and anterior skull base surgeries. The presence of AEA in all of the images examined in this study is consistent with the observed range of 92-100 percent. [10,11]

The AEA was identified to have a varying path in the ethmoidal air sinus. It was observed at SB in 16.5 percent and below SB in 83.5 percent, which corresponds with previous studies showing 20% and 80%, 32.7 percent and 67.3 percent, respectively. A comparative distance between AEA and SB among different authors reveals that group A is seen most oftenly, with the exception of one study where group C was found to be prevalent. The total mean distance between the AEA and SB was 3.65 mm, which is comparable with previous studies' mean values of 3.18 mm and 4.86 mm. [12,13]

Endoscopic surgeons use the depth of the olfactory fossa as a guiding marker. With the exception of one study that found Kero's type I to be the most common, all earlier reports, even this one, found Kero's type II to be the most prevalent. [14]

Increased olfactory fossa depth increases the possibility of AEA coursing easily within the ethmoid sinus. The distance between the AEA canal and the SB increases in a definitive manner as the depth of the olfactory fossa increases. In such cases, the possibility of AEA iatrogenic injury increases. On the contrary, the majority of the AEA coursing very near to the skull base (<2.5 mm) signifies a safer course and less risk of injury during treatments. [15]
However, apart from the relationship to lateral lamellar height, which could change the position of AEA, pneumatization of ethmoid air cells and the presence of large supraorbital cells have been contributed as causes for differences in AEA position relative to SB. Kero's type was proposed as a predictive factor in determining the relational distance between AEA and SB, along with ethmoid pneumatization. The current study did not have the resources to investigate this causative relationship. [16,17]

CONCLUSION

The difference in distance between AEA and SB is due to the length of the lateral lamella of the cribriform fossa. There is some variation in the morphology of the olfactory fossa. Despite the statistical limitations, the positional relationship between AEA and depth of olfactory fossa is significant. The presence of an anterior ethmoid artery outside the skull base with a long lateral lamella would aid the surgeon in avoiding intraoperative complications during endoscopic skull base or sinus surgery.

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