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Original Article

Radiological correlation between the anterior ethmoidal artery and the supraorbital ethmoid cell.

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Abstract

The anterior ethmoidal artery is an important landmark in functional endoscopic sinus surgery.

Aims We undertook this study to determine the reliability of identification of the artery on the coronal CT scan and to determine whether a correlation exists between the pneumatisation of the suprabullar recess and the vertical distance of the artery from the base skull.

Materials and Methods 50 randomly selected CT scans were studied. The anterior ethmoidal artery was identified on each side and the vertical distance between the artery and the base skull was measured. The orbital beak and the superior oblique muscle were used as landmarks to identify the artery. The CT scans were divided into two groups based on whether the supraorbital cell was present or absent. These groups were each further subdivided into 3 groups depending on the vertical distance between the anterior ethmoidal artery and the base skull.

Results The anterior ethmoidal artery was reliably identified in 97% of the cases. When the supraorbital cell was absent, the mean distance between the artery and the base skull was 1.5 mm; while when the cell was present, the mean distance was 4.86 mm. When these groups were evaluated for statistical significance, the p value was 0.000 (highly significant).

Conclusion The orbital beak and superior oblique muscle are reliable landmarks to identify the anterior ethmoidal artery. There exists a strong correlation between the vertical distance of the artery from the base skull and the presence of the supraorbital ethmoid cell.

Keywords CT scan · Complications of FESS · Anatomy · Suprabullar recess · Landmarks.

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Introduction

The anterior ethmoidal artery (AEA) is an important landmark in functional endoscopic sinus surgery (FESS) and in endoscopic orbital decompression. Iatrogenic injury may result in retraction of the artery into the orbit, with consequent intra-orbital bleeding and possible blindness. It is a branch of the ophthalmic artery, which itself arises from the internal carotid artery. It pierces the medial orbital wall at the frontoethmoidal suture line and passes through anterior ethmoidal foramen on the medial wall of the orbit. It then enters the ethmoidal sinuses and follows a variable course to supply the mucosa and to send branches to the upper part of the nasal cavity. It may be closely apposed to the skull base, or traverse the ethmoids, either freely or within a bony canal [1]. The knowledge of such anatomical differences is vital in minimizing the risk of damage to the artery and the possible consequences.

Computerized Tomography (CT) scans are accepted as the gold standard in diagnosing diseases involving the

paranasal sinuses. These scans are used as road maps while operating on the paranasal sinuses. Hence, it is essential for the otolaryngologist to be able to read the CT scan by himself. Accurate localization of the AEA pre-operatively would help in avoiding damage to the artery. Despite the vast data published in literature about the anatomy of the anterior ethmoidal artery1-10, there are not many studies which correlate the presence of the supraorbital ethmoid cell and the location of the AEA.

We would like to present an easy and reliable method of detecting the position of the AEA on the CT scan as it enters the ethmoid sinuses, which will be helpful in preventing morbid complications during endoscopic sinus surgery. We would also like to determine whether a correlation exists between the pneumatisation of the suprabullar recess and the distance between the AEA and the base skull.

Aims

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

Materials and Methods

The CT scans of 50 patients were selected randomly and studied. These CT scans were performed using 4-slice multi-detector CT scanner (SIEMENS). The slice thickness of the scans was 3 mm. The AEA was identified on coronal CT scans (bone windows) on each side and its distance from the base skull measured individually (in millimetres). The bony canal of the AEA was identified running across the ethmoidal cavity.

The CT scans were divided into 2 groups, viz., those with supra-orbital cells and those in which supra-orbital cell (SO cell) was absent. Each group was further subdivided into 3 sub-groups based on the distance of the anterior ethmoidal artery from the base skull as follows:

Group I – < 2.5 mm, Group II – 2.5 – 5 mm and Group III – > 5 mm (Figs. 1 (a), (b), (c) respectively).

Observations and Results

Out of the 100 sides studied, the supra-orbital cell was present in 45 sides while it was absent in the remaining 55 sides.

The anterior ethmoidal artery was reliably identified in 97 sides (97%) while it could not be identified in 3% on the CT scan.

Amongst all the patients, only 20% of the AEA were seen in the base skull while 80% of the AEA were seen lying at a level lower than the base skull. (Graph I)

The observations pertaining to the distance between the AEA and the base skull in the two groups are given in Table 1.

These values are represented as percentages in Graph 2.

When the SO cell was absent, the anterior ethmoidal artery was seen close to the base skull (< 2.5 mm) in 75.9% (41 out of 54) of the sides, while in the remaining 24.1% of the sides, it was seen at a distance of more than 2.5 mm (Groups II & III) from the base skull.

However, when the SO cell was present, the anterior ethmoidal artery was seen at a distance of more than 2.5 mm (Groups II & III) from the base skull in 86% (37 out of 43) of the sides, whereas it was close to the base skull in only 14% of the sides (Group I).

When these two groups were analysed for statistical significance (using the Chi-square test), the p value was 0.000, which is highly significant.

The mean distance of the AEA from the base skull was calculated for each group. This data is represented in Table 2.

When the mean distance of the AEA from the base skull for each group was compared (using the t-test), we found that the p value was 0.000 (highly significant).

We observed a side to side variation in the same patient of more than 1 mm in the location of the AEA from the base skull in 15 patients (30%). (Fig. 2)

Table 1 Distance between Anterior Ethmoidal Artery and Skull Base

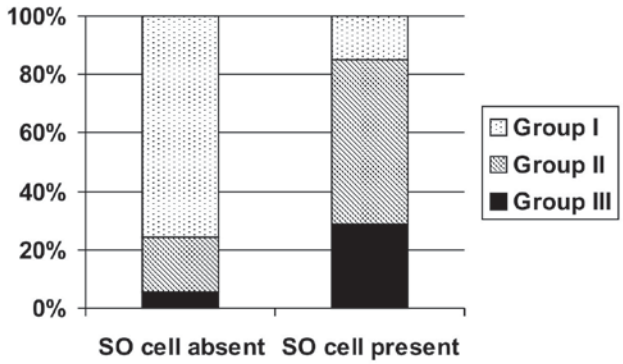
n = 97*	Supraorbital cell absent (n=54)	Supraorbital cell present (n=43)
Group I (< 2.5 mm)	41	6
Group II (2.5 – 5 mm)	10	23
Group III (> 5 mm)	3	14

(* n = 97 as artery not identified in 3 sides out of 100)

Table 2 Mean distance of Anterior Ethmoidal Artery from Base Skull

Supraorbital cell	n	Mean distance of Anterior Ethmoidal Artery from Base Skull
Absent	54	1.50 mm
Present	43	4.86 mm

Graph 1 Graph representing location of AEA at Base Skull v/s lower than the Base Skull



Graph 2 Graph representing distance of AEA from Base Skull (as percentage)

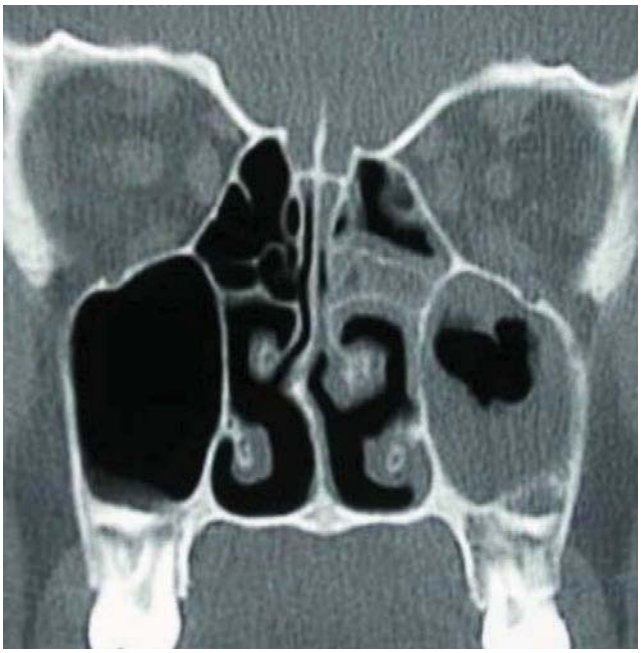


Fig. 1 (a) Distance between AEA and Base Skull < 2.5 mm (Group I)

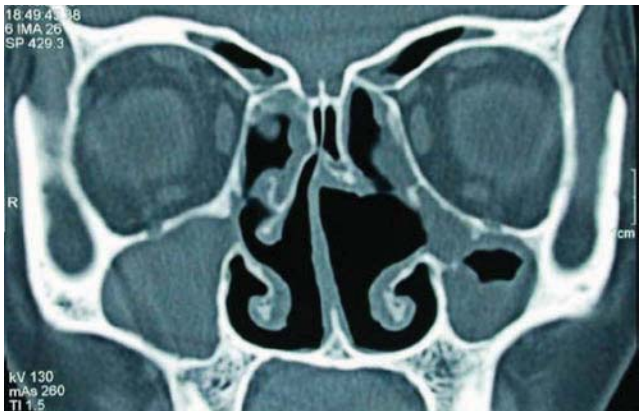


Fig. 1 (b) Distance between AEA and Base Skull between 2.5 – 5 mm (Group II)

Fig. 1 (c) Distance between AEA and Base Skull > 5 mm (Group III)

Fig. 2 CT scan showing side-to-side variation in distance of AEA from Base Skull

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Fig. 3 CT scan showing orbital beak (black circle) and superior oblique muscle (white circle)

Fig. 4 (a) Coronal CT scan with supraorbital cell showing vertical distance between anterior ethmoidal artery and base skull (marked with thick white double arrow)

The anterior ethmoidal artery appeared to be without a bony canal on the CT scan on 4 sides (4%).

Discussion

A thorough review of the literature revealed a few studies done with regards to the position of the AEA in the ethmoid cavity1-11. All the studies unanimously agree that the vertical distance of the AEA from the base skull

Fig. 4 (b) Coronal CT scan without supraorbital cell showing vertical distance between anterior ethmoidal artery and base skull (marked with thick white double arrow)

is variable. In our study, we would like to present a very simple and reliable method of identifying the AEA on the CT scan. In addition, we present our data on the variability of the vertical distance of the AEA from the base skull. We have also found a correlation between the position of the AEA and the presence or absence of the supraorbital ethmoid cell.

We were able to identify the AEA in 97% of our patients. This figure is comparable to international literature [11]. We sought to identify the AEA on the coronal CT scan in the bone windows. The AEA was identified at the level of the orbital beak formed at the junction of the superior and the medial orbital wall. Another prominent landmark at this site was the presence of the superior oblique muscle in the orbit (Fig. 3). The orbital beak is defined as the prominent triangular part of bone seen at the junction of the superior and the medial orbital walls. The AEA is further traced as a bony canal from this orbital beak.

As mentioned earlier, this is one of the most reliable methods to identify the AEA as it uses landmarks like the superior oblique muscle which runs in an antero-posterior direction. Hence, this landmark is better than using the anterior lacrimal crest which was used in previous studies as this crest is vertically oriented [11]. Also the orbital beak is a constant bony landmark when compared to the vertical attachment of the middle turbinate which can be variable in position. However, the most important advantage of this method is that these landmarks are preserved even in extensive pathologies of the paranasal sinuses.

In our series only 20% of the arteries lay in the base skull, while the remaining 80% of the arteries had a mesentery

by which they were suspended from the base skull. These figures indicate that the AEA is at risk during surgery in majority of the cases if it is not assessed carefully on the CT scan.

There exists a strong correlation between the vertical distance of the AEA from the base skull and the presence of the supraorbital ethmoid cell. In cases where the supraorbital ethmoid cell is present, the AEA crosses the ethmoid cavity at a much lower level (Fig. 4 (a)) as compared to when the supraorbital ethmoid cell is absent (Fig. 4 (b)). Hence it must be kept in mind that the AEA is more susceptible to injury in cases when the supraorbital ethmoid cell is present.

The position of the AEA may show variations between the two sides in a single patient. The possibility of such a variation must be known to the endoscopic sinus surgeon.

Identification of the AEA pre-operatively on the CT scan will help to minimise chances of damage to the artery during surgery. Also, it is a helpful landmark during surgery for evacuation of an orbital hematoma or endoscopic drainage of orbital abscess.

Key Message

It has been unanimously agreed that the identification of the AEA is important for safe endoscopic sinus surgery. It is also well known that the course of the AEA is very variable with regards to its vertical distance from the base skull.

In this study, we provide a very simple and reliable method for identifying the AEA using the orbital beak and the superior oblique muscle as the anatomical landmarks.

We conclude that there exists a strong correlation between the vertical distance of the AEA from the base skull and the presence of the supraorbital ethmoid cell. Hence, the artery could be at a greater risk of damage during surgery when the supraorbital ethmoid cell is present.

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