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Research Article

Prevalence of Prominent Ethmoid Bulla and Agger Nasi Cell in Adult Nigerians and Their Clinical Implications: CT Study

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Abstract

Objective: Extensively pneumatized variant cells of the ethmoid sinus may compromise the drainage pathway of the paranasal sinuses hence predisposing to sinusitis. This study elucidates the prevalence of prominent ethmoid bulla and Agger Nasi cell in adult Nigerians.

Methods: After obtaining ethical approval, we evaluated brain computed tomography images of adult patients (137 females and 199 males), archived in the Radiology unit of a Teaching Hospital in Nigeria. These images were investigated for the presence of a prominent ethmoid bulla and Agger Nasi cells. Using the Statistical Package for Social Sciences version 23, the prevalence of these cells was analyzed and their association with side and gender was evaluated using the Chi-Square test. Statistical significance was considered at p level of < 0.05.

Results: The prevalence of prominent ethmoid bulla and Agger Nasi cell was 88 (26.2%) and 133 (39.6%) respectively. These cells were more commonly observed unilaterally in 67 (76.1%) and 78 (58.6%) patients respectively. There was a higher propensity of the unilateral prominent ethmoid bulla and Agger Nasi cell to occur on the left side (40, 59.7%) and right side (59, 75.6%) correspondingly. Both variants were significantly associated with their side of existence ($p = 0.001$).

Conclusion: The prominent ethmoid bulla and Agger Nasi cell commonly existed unilaterally in the studied population. Therefore, otorhinolaryngologists in the studied area need to consider the radiological identification of these cells in explicating the pathogenesis of recurrent frontal sinusitis as well as mitigating complications during sinus surgery.

Keywords: Agger Nasi; Drainage; Ethmoid; Bulla; Sinus

Introduction

The paranasal air cells inside the labyrinth of the ethmoid bone constitute the ethmoid sinus (ES) [1]. The ES roof is formed by the orbital plate of the frontal bone, which is also referred to as the fovea ethmoidalis. The lamina papyracea forms the lateral wall of the ES. This sinus abuts the lacrimal bone and the sphenoid sinus anteriorly and posteriorly respectively [2]. The air cells of the ES are divided into three groups namely anterior, middle and posterior ethmoidal air cells. The anterior and middle ethmoid cells drain into the nasal cavity through the middle meatus. On the other hand, the posterior ethmoid cells drain via the posterior part of the superior meatus [1,2]. The air cells of the ES have a varying pneumatization pattern whereby, they may aerate externally from the ethmoid labyrinth (extramural cells) or may remain intimate to the

labyrinth (intramural cells) [3]. The ethmoid bulla is an intramural cell of the ES with a variable size ranging from torus ethmoidalis (non-pneumatized) to a giant ethmoid bulla [2]. The ethmoid bulla is the largest anterior ethmoidal cell with non-variant pneumatization, hence considered the most consistent air cell. It is formed by aeration of the distinct bony lamella, referred to as the bulla lamella [4]. It is intimate to the osteomeatal complex (OMC) and forms the supero-posterior relations of the hiatus semilunaris as well as the ethmoid infundibulum [1,5].

Agger Nasi cell (ANC) is an extramural cell which is commonly identified as the most anterior ethmoid air cell that extends into the lacrimal bone and opens into the ethmoidal infundibulum [6,7]. Its lateral relations include the orbit and its related structures such as the nasolacrimal duct and the lacrimal sac. This cell can invade the adjacent bony structures such as the lacrimal bone and the maxilla [1,3]. In relation to the frontal recess, the ANC is located anterolaterally and inferior to the recess. Moreover, it extends anterosuperiorly to the attachment of the middle concha [1,8]. Pediatric patients have a lower prevalence of the ANC. However, this cell progressively develops even after the completion of ES development. This further growth of the ANC is mainly caused by the age-related expansion of the FS [4].

The prevalence of a prominent ethmoid bulla and ANC vary in different population groups [8-13]. The proximity of these air cells to the main drainage pathways of the paranasal sinuses reduces the mucociliary clearance of the sinuses [3]. An ethmoid bulla located amid the middle concha and uncinate process may be hyperpneumatized and displace the UP medially [4]. The presence, location and variant pneumatization patterns of the ANC alter the dimensions and boundaries of the frontal recess and size of FS ostium, hence, contribute to anatomical variability of the frontal recess [4,13,14]. These predispose to recurrent sinusitis, therefore, increasing the need for endoscopic sinus surgery (ESS) [3]. The ANC may extensively pneumatize and subsequently dislocate the middle turbinate shifting its position and insertion superomedially. Consequently, this may result in the obstruction of the nasolacrimal duct [7,8].

Computed Tomography (CT) is an accurate imaging modality for preoperative evaluation of the complex anatomy and pathologies of the paranasal air sinuses in addition to their drainage pathways [1,8]. It accurately depicts the variable framework of the frontal recess besides its adjacent structures [4,14]. This study aimed at determining the prevalence of prominent ethmoid bulla and ANC in adult Nigerians and elucidate their clinical significance.

Materials and Methods

We retrospectively performed this cross-sectional study using Brain CT images in the Picture Archiving Communication System (PACS) database of the Radiology Department of a Teaching Hospital in Nigeria. Images of patients referred for cranial CT within a 5 years' duration, spanning from 1st June 2015 to 30th June 2020 were utilized. These belonged to patients who complained of persistent headache and those with suspected stroke or space occupying lesions. A 64 slice CT scanner (Toshiba Aquilon, Japan) was used to acquire these images at a setting of 120kV and 300mA and in 3-5mm thick axial slices. Our inclusion criteria entailed good quality CT images of patients from both genders and aged 20 years and above. We excluded the images with artefacts, incomplete demographic data, presence of sinonasal pathological lesions such as mucosal thickening, polyps, craniofacial anomalies, trauma and evidence of previous sinus surgery. The Hospital's Ethics Committee granted approval for this study before accessing the radiological database (EREC/PAN/2020/030/0371).

We evaluated sagittal and coronal reformatted images of 336 patients for the presence of prominent ethmoid bulla and ANC on the right and left sides. The prominent ethmoid bulla was defined as the largest anteriorly positioned ethmoid air cell which was located between the middle turbinate and uncinate process. The ANC was identified as the most anteriorly located ethmoidal air cell lying on the lateral wall of the nasal cavity and anterosuperior to the hiatus semilunaris. The cell was observed lateral to the position of the middle turbinate and medial to the lacrimal bone on coronal plane [1]. Data were tabulated on data sheets and analysis was accomplished using the Statistical Package for Social Sciences (SPSS) version 23 (IBM Corporation, Armonk, New York, USA). The frequencies of the ethmoid cell variants were presented in tables. The Chi-Square test was employed to establish any relationship between these cells (ANC and prominent ethmoid bulla) and side of occurrence or gender. The level of significance was set at < 0.05.

Results

The 336 brain CT images evaluated herein predominantly comprised 199 males (59.2%) and the remaining 137 (40.8%) pa-

tients were females. These were patients aged between 20 years and 99 years, and their average age was 53.29 ± 18.18 years. The prevalence of prominent ethmoid bulla was 26.2% (88) (Figure 1). This cell had a higher prevalence in males than in females on both sides, however, the gender difference lacked statistical significance (*P* 0.257,0.590) (Table 1). Its unilateral occurrence was more (67, 76.1%) than the bilateral existence (21, 23.9%). The unilateral prominent ethmoid bulla was more commonly observed on the left (40, 59.7%) than on the right (27, 40.3%). Furthermore, there was a significant relationship between the presence of a prominent ethmoid bulla and the side of its occurrence (*P* 0.001) (Table 2).

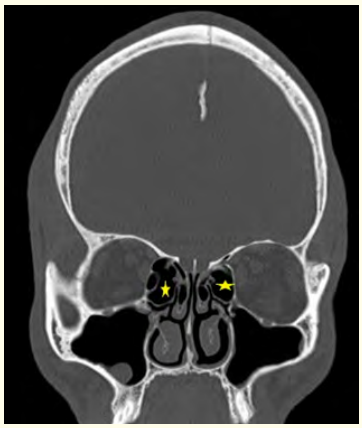

Figure 1: Coronal reformatted CT image showing a prominent ethmoid bulla bilaterally.

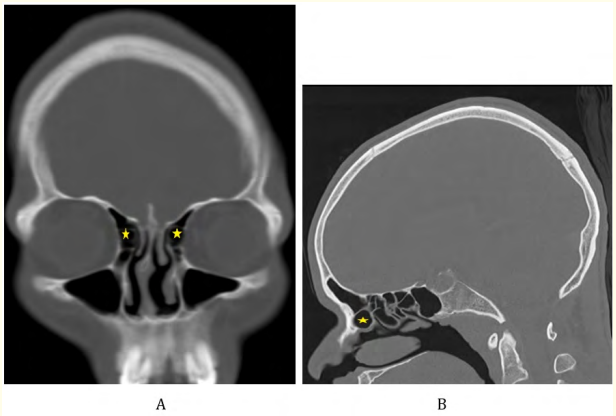

Figure 2: Coronal (A) and Sagittal (B) reformatted CT images showing the Agger Nasi cell.

The ANC had a prevalence of 133, 39.6% occurring more unilaterally (78, 58.6%) than bilaterally (55, 41.4%) (Figs 2A and 2B). Its unilateral existence was more on the right (59, 75.6%) than on the left side (19, 24.4%). The side difference in the occurrence of the ANC was statistically significant (*P* 0.001) (Table 2). Its prevalence was higher in females than in males on both sides, although, not statistically significant (*P* 0.903, 0.825) (Table 1).

	Prominent ethmoid bulla				Agger Nasi cell			
	Right		Left		Right		Left	
Female	16	11.7	23	16.8	47	34.3	31	22.6
Male	32	16.1	38	19.1	67	33.7	43	21.6
Total	48	14.3	61	18.2	114	33.9	74	22
P value	0.257		0.590		0.903		0.825	

Table 1: Gender distribution of prominent ethmoid bulla and ANC.

Variant	Right (%)	Left (%)	P value
Prominent ethmoid bulla	48 (14.3)	61(18.2)	0.001*
Agger Nasi Cell	114 (33.9)	74 (22)	0.001*

Table 2: Side Differences in the prevalence of Prominent ethmoid bulla and Agger Nasi cell.

*p considered significant at < 0.05.

Discussion

The prevalence of a prominent ethmoid bulla in the Nigerian population studied herein was 26.2%. This was lower than 89%, 32.8%, 43.2% and 44.8% documented in Australia, Italy, Sudan and America correspondingly [9,11,12,15]. On the other hand, our prevalence was higher than 6.3% observed among the Turkish patients studied by Dasar and Gokce [10]. The prominent ethmoid bulla varied in the different Indian populations studied in literature whereby Arya and Kapoor [1] documented a lower prevalence (6%) compared to our finding while Sheikh., *et al*. [16] documented a higher prevalence (46%).

The prevalence of the ANC was 39.6% which was higher than 23.6% documented in Rivers State, Nigeria and lower than 44.7% and 59.6% observed in Osun State, Nigeria [2,17,18]. Our finding was within the range documented in India but lower than the findings in Phillipines [1,19,20]. Additionally, it was lower than

the documented reports among the Arabs of Iran and Saudi Arabia [21,22]. Higher frequencies were reported in Australia (96%), Turkey (72%), and America (70.6%) [5,12,15]. According to a cadaveric study by Ximendes., *et al*. [13] in Brazil, endoscopic evaluation revealed a higher prevalence of ANC (88.4%) compared to our findings.

The discrepancies in the frequency of the prominent ethmoid bulla and ANC as documented in literature could be ascribed to the racial variations as well as environmental and geographical factors which influence the pneumatization of the paranasal sinuses [13]. Furthermore, the variations within a given population group of the same geographical region may be attributed to the differences in genetics and ethnicity as well as individual differences and previous paranasal infections that affect the development of the sinuses [22]. The differences in the study designs, methodology (CT versus endoscopic), CT slice thickness, experience of the investigator, sample size, and variable anatomical definition of the cells may also contribute to the wide variability [13,17,23]. The dissimilarities in the sample composition could also explain the divergent prevalence of the cells. For instance, studies that included patients with frontal sinusitis and nasolacrimal duct obstruction documented a higher prevalence of ANC compared to studies involving apparently healthy subjects [7,8,22].

The prominent ethmoid bulla and ANC in the studied population commonly occurred unilaterally and this contrasted with the findings by Liu., *et al*. [24] and Moeini., *et al*. [22] who observed a higher prevalence of bilateral ANC among the Taiwanese and Iranians respectively. Our study revealed a significantly higher propensity of prominent ethmoid bulla and ANC occurring to the left and right side correspondingly. This significant side difference could be ascribed to the independent embryonic development of craniofacial structures on each side that is responsible for morphological asymmetry. The lack of association between these variants and gender in the current study may imply that the sex determining genes and sex hormones have limited influence in their existence. Correspondingly, Moeini., *et al*. [22] documented no significant gender difference in the prevalence of the ANC among Iranian adults.

It is important for otorhinolaryngologists to be cognizant of the prominent ethmoid bulla since its extensive pneumatization may compromise the OMC and increase the risk of sinus infection, polyps and cysts [5,11]. The understanding of the existence of the ANC is imperative due to its proximity to the lacrimal fossa laterally which increases the risk of epiphora, dacrocystitis and visual symptoms when enlarged [7]. The ANC forms the anteroinferior border of the frontal recess and when enlarged, it displaces the recess posteromedially. This leads to the impingement of the frontal sinus drainage pathway thus obstructing the mucociliary clearance and consequently predisposing to frontal sinusitis [4]. During ESS, the ANC serves as an important landmark of the frontal recess and provides surgical access to the frontal sinus and frontal recess [6,14,22]. A hyperpneumatized ANC predisposes to surgical complications such as leakage of cerebrospinal fluid and ocular trauma owing to the close proximity of the frontal recess to the orbit, olfactory fossa and the skull base on the anterior cranial fossa [22,23]. It is therefore crucial for surgeons to be aware of the ANC existence to curtail these complications during ESS [6].

Conclusion

The prominent ethmoid bulla and Agger Nasi cell commonly existed unilaterally in the studied population. Therefore, otorhinolaryngologists in the studied area need to consider the radiological identification of these cells in explicating the pathogenesis of recurrent frontal sinusitis as well as mitigating complications during sinus surgery.

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Conflict of Interest

We have no conflict of interest to declare.

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