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Spectrum of Anatomical Variations in Paranasal Sinuses Detected on CT PNS Pre FESS

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Abstract: Conventional radiography has been largely replaced by high-resolution CT scan of the paranasal sinuses (PNS) for evaluating congenital anatomical variations and sinus pathologies [1-3]. In this retrospective study, we evaluated 1,450 CT scans of the paranasal sinuses to determine the prevalence of various anatomical variations. Patients aged 15 to 85 years were included, while those with bone destruction or distortion due to surgery, trauma, or other pathologies were excluded. The most common variation observed was a deviated nasal septum (DNS) in 603 cases (41.6%), followed by Agger nasi cells in 548 cases (37.8%), concha bullosa in 302 cases (20.8%), bony nasal spur in 181 cases (12.5%), hypoplastic frontal sinus in 116 cases (8.0%), Haller cells in 44 cases (3.0%), Onodi cells in 29 cases (2.0%), pneumatization of the vomer bone in 15 cases (1.0%), and septate maxillary sinus in 12 cases (0.8%).
Keywords: CT, PNS, FESS.

INTRODUCTION

Anatomical variations of the paranasal sinuses are common and may significantly impact the drainage pathways of the sinuses, potentially leading to chronic sinusitis. These variations, including septal deviations, concha bullosa, and variations in ethmoidal air cells, can alter the ventilation and mucociliary clearance, especially around the osteomeatal complex. With the increasing utilization of functional endoscopic sinus surgery (FESS), understanding such anatomical differences has become crucial for safe and effective surgical outcomes. Computed Tomography (CT) is currently the modality of choice for preoperative assessment of these variations due to its high-resolution multiplanar capabilities.

MATERIALS AND METHODS

This observational study was conducted over 6 months (November 2017 to March 2018). A total of 1,450 patients aged between 18- and 70-years undergoing CT scans of the paranasal sinuses were included. Patients with previous sinus surgery, traumatic deformities, or destructive lesions affecting sinus anatomy were excluded. Scans were performed using a GE MDCT scanner. Scan were reconstructed in orthogonal planes. Anatomical variations including deviated nasal septum (DNS), Agger nasi cells, concha bullosa, Haller and Onodi cells, bony nasal spurs, hypoplastic frontal sinuses, vomer bone pneumatization, and septated maxillary sinuses were described.

RESULTS

Out of 1,450 patients, 1,001 (69%) exhibited one or more anatomical variations.

- Deviated nasal septum (DNS) was seen in 603 patients (41.6%)
- Agger nasi cells in 548 patients (37.8%)
- Concha bullosa in 302 patients (20.8%)
- Bony nasal spur in 181 patients (12.5%)
- Hypoplastic frontal sinus in 116 patients (8.0%)
- Haller cells in 44 patients (3.0%)
- Onodi cells in 29 patients (2.0%)
- Pneumatization of vomer bone in 15 patients (1.0%)
- Septate maxillary sinus in 12 patients (0.8%)

A significant association was observed between DNS and ipsilateral bony nasal spur, present in 28.96% of patients with DNS.

Additionally, approximately 55% of patients with anatomical variations also exhibited signs of sinusitis, compared to 18.06% in those without anatomical variations.

DISCUSSION

Assessment of anatomical variations of the paranasal sinuses (PNS) using computed tomography (CT) plays a crucial role in both diagnostic and preoperative settings. Variations such as deviated nasal septum, concha bullosa, agger nasi cells, Haller and

Onodi cells, and bony nasal spurs are commonly encountered and can significantly influence sinus ventilation and drainage. These structural differences may predispose individuals to recurrent or chronic rhinosinusitis by obstructing the osteomeatal complex or altering mucociliary clearance [4].

High-resolution CT provides superior delineation of these variants compared to conventional radiography, allowing precise anatomical mapping. This is particularly vital prior to endoscopic sinus surgery, where unrecognized variants can lead to intraoperative complications such as optic nerve or internal carotid artery injury. Additionally, identification of anatomical variants assists radiologists and ENT surgeons in correlating clinical symptoms with structural causes and planning personalized management strategies.

Our findings are in line with previous studies indicating that anatomical variations play a significant role in the etiology of sinusitis. Gupta N *et al.,*(2017) and Harrison DF. *et al.,*(2015) have reported similar frequencies of variations such as DNS and concha bullosa. The association between unilateral concha bullosa and contralateral septal deviation supports theories on compensatory hypertrophy (Bolger WE *et al.,* 1991 and Smith KD *et al.,* 2010). The presence of Agger nasi cells and their proximity to the frontal recess underscores their role in frontal sinusitis (Smith KD *et al.,* 2010). Recognition of these variants can assist in surgical planning and reduce complications during FESS.

CONCLUSION

Preoperative CT evaluation is essential for identifying anatomical variants to optimize surgical planning and outcomes in patients undergoing FESS.

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