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RESEARCH ARTICLE

PREVALENCE AND VARIATION OF HALLER'S CELLS ON CBCT IMAGES AND ITS CORRELATION WITH MAXILLARY SINUS PATHOLOGIES

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ABSTRACT

Objectives: To evaluate size, shape, number of Haller's cells and its correlation with maxillary sinus pathologies, nasal septum deviation.
Study Design: 56 full FOV CBCT scans were retrospectively analysed. All the CBCT scans were obtained from same CBCT centre over a period of 6 months. Size of Haller's cells were measured by measuring the maximum mesiodistal diameter on coronal slices of CBCT scans bilaterally. All the above scans were then analysed. Maxillary sinus pathologies were categorised as Mucosal thickening, Poypoidal thickening, Opacification.
Results: Chi square test was used for statistical analysis to evaluate the correlation between the presence of Haller's cells and Maxillary sinus pathologies. And was found to be stastically significant. ($p<0.05$)
Conclusion: We conclude that Haller's cells can be considered as an important contributing factor for maxillary sinusitis.

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INTRODUCTION

The paranasal sinuses are air-filled spaces it include the frontal, ethmoidal, sphenoidal and maxillary sinuses.The ethmoid sinuses are small, thin-walled cavities in the ethmoidal labyrinth. They may vary in number, shape. The ethmoidal sinuses consist of anterior, middle and posterior groups present bilaterally (Gray's Anatomy, 1995). The infrorbital ethmoidal cells are present as the continuation of ethmoidal capsule present on medial orbital floor and roof of maxillary sinus. It is a anatomical variation in the development of nose and paranasal sinus. Haller's cells were first discovered by Swiss Physician Albrecht Von Haller (1708-1777) in year 1743. By 1765 this cells were named after him as HALLER'S CELLS he described this ethmoid pneumatization of the inferior bony wall of the orbit (Ahmed *et al*., 2006 and Shetty *et al*., 2015). These are also named as "Orbitoethmoid cells", "maxilloethmoid cells", Infraorbital ethmoidal cells. Ethmoidal cells not only extend in anterior region forming infra orbital ethmoidal cells in the posterior segment of ethmoid sinus extension superiolaterally to sphenoid sinus is known as onodi cells.The posterior extension is not recorded in our study. Although anatomic variations, in the development of the nose and paranasal sinuses the Haller's cells do not represent a disease state, many of the studies have pointed out that they are responsible for the maxillary sinus pathologies. Haller's cells may become enlarged and cause obstruction of the posterior aspect of the ethmoidal infundibulum and ostium of the maxillary sinus leading to maxillary sinusitis (Kantarci *et al*., 2004 and Braun *et al*., 2013). This also has been associated with, headache and mucoceles (Shetty *et al*., 2015). These entities may be easily overlooked by dental professional. Unless specifically sought. However, the literature lacks studies describing the characteristics or prevalence of haller's cells on CBCT images. Advantage of low dose and greater sensitivity CBCT is considered as better modality compared to CT. Haller's cells may be visualized by CT and maxillary sinus endoscopy. But may be missed due to difference in image acquisition protocol (Wanamaker *et al*., 1996) Also they cannot be diagnosed by endoscopy alone as they are hidden lateral to the uncinate (Wanamaker *et al*., 1996). A retrospective study was planned with an objective to find out prevalence of Haller's cells and its correlation to maxillary sinus pathologies. CBCT imaging can further be used as a imaging modality for preoperative bony structure evaluation for endoscopic sinus surgery.

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MATERIALS AND METHODS

Study design

Aim : To determine the prevalence of Haller's cells on CBCT images

Objectives

- To evaluate size, shape, number of Haller's cells on CBCT.
- To evaluate the size of Haller's cells and its correlation with maxillary sinus pathologies.

Inclusion Criteria

- Age range from 18years and above.
- All CBCT scans that were referred for dentomaxillofacial indications Dental implants, Orthodontics, Endodontics, Exodontia.
- A prior informed consent was obtained for assessing CBCT scans for research work.IRB approval was taken prior to the study.

Exclusion Criteria

Patients younger than 16 years of age. No patient had been primarily referred for a CBCT scan of the maxillary sinus because of sinus symptoms or suspected diseases.Patients with mid face trauma, pathologies due to odontogenic origin, periapical lesions. Images of low resolution quality and those in which the presence of metallic artifacts obscured sinus visualization were excluded from the study. 56 full FOV CBCT scans (CS93000 MACHINE) were retrospectively analysed for presence and sizes of Haller's cells then the same scans were evaluated for maxillary sinus pathologies. All the CBCT scans were obtained from same CBCT centre over a period of 6 months. The CBCT images were viewed using Kodak carestream software on coronal, sagital, axial slices.

MATERIALS AND METHODS

Criteria to recognise Haller's cells

Cells of any size located along the medial portion of orbital floor and continuous with ethmoidal capsule.

Criteria to determine the size of Haller's cells

Size of Haller's cells were measured by measuring the maximum mesiodistal diameter on coronal slices of CBCT scans (Fig.1). The unilateral and bilateral distribution of Haller's cells were determined. Size of Haller's cells were then divided into: (1-2.2 mm) small, (2.3-4.0mm) medium (4.1-above) large. Maxillary sinus pathologies were categorised as-Mucosal thickening. Poypoidal thickening, Opacification. Data obtained was analysed using chi-square test.

RESULTS

Total number of scans examined were 56 out of which 45 scans (78%) =119 haller's cells showed presence of Hallers cells and 11 scans (21.4%) without presence of haller's cells, (Graph: 1). Out of 45 scans with haller's cells, 19 scans shows haller's cells without pathologies and 26 scans of haller's cells with pathologies. The scans were then divided for unilateral and bilateral presence of Haller's cells .17 scans (37%) showed unilateral involvement and 28(62%) with bilateral presence of haller's cells (Graph 3).

There is slight female predilection 25 scans (56%) of females showed presence of Haller's cells and 20 scans (44%) males showed presence of haller's cells. The shape of the haller's cells were determined by referring all the three sections axial coronal and sagital. It was seen that majority of the haller's cells were round 53 (69%), oval 18(23%) and trapezoidal 5(6%). Haller's cells size ranged from 1.4to 6.8 mm maximum were of the medium size (2.2-4.0mm) which was statistically significant (p=0.004) followed by larger size (4.1-6.8mm), (Table 2). Chi square test was used for statistical analysis to evaluate the association between presence of Size of Haller's cells and Maxillary sinus pathologies. The P value <0.05 significant. Unilateral haller's cells shows significant correlation with presence of Haller's cells and maxillary sinus pathologies with P - 0.031. The medium size cells (2.2-4.0mm) shows maximum number of pathologies (Table 1).

Table 1. Unilateral distribution of Haller's cells

Unilateral Haller's cells	Maxillary sinus Pathology	P value	Nasal septum deviation	P value	Orbital floor dehiscence	P value
1.4-2.2mm	2	0.031*	1	0.23	0	0.12
2.2-4.0mm	8		6		0	
4.2-5.6mm	5		6		2	

*p<0.05 significant

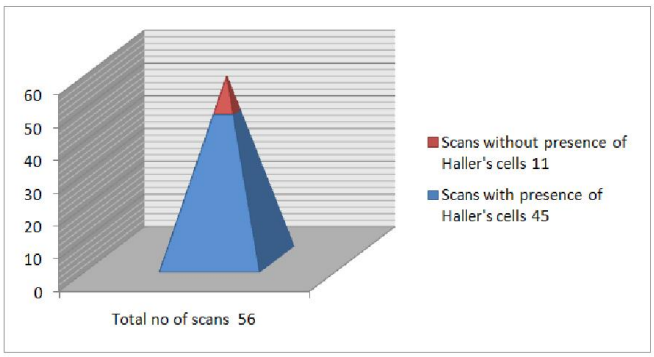
Table 2. Bilateral distribution of Haller's cells

Bilateral Haller's cells	Maxillary sinus Pathology	P value	Nasal septum deviation	P value	Orbital dehiscence	P value
1.5-2.2mm	12	0.004*	12	0.02*	2	0.040*
2.3-4.0mm	23		7		3	
4.1-6.8mm	13		8		5	

*p<0.05 significant

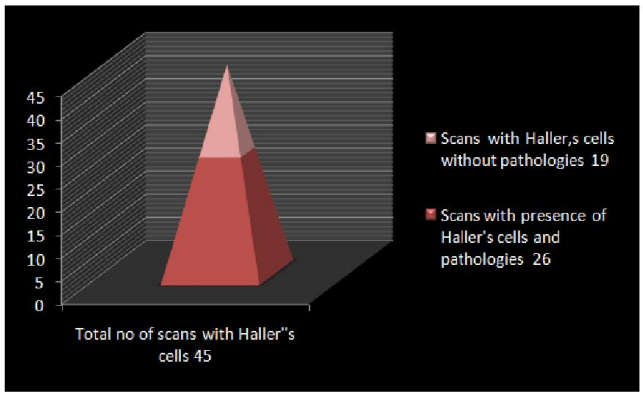
Table 3. Distribution of Haller's cells with individual Maxillary sinus

Size of haller's cells	Mucosal thickening	P value	Mucosal polyp	P value	Polypoidal thikening	P value	Opacification	P value
1.5-2.2mm	2	0.03*	6	0.29	3	0.18	2	0.34
2.3-4.0mm	12		7		2		4	
4.1-6.7mm	10		5		0		2	

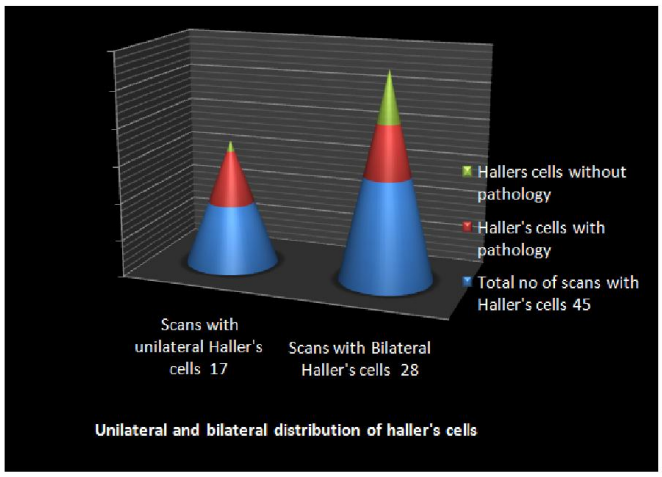


Total number of Haller's cells 119.

Graph 1. Total number of CBCT scans examined



Graph 2. Total number of scans with maxillary sinus pathologies and without maxillary sinus pathologies in presence of Haller's cells



Graph 3. Unilateral and bilateral distribution of Haller's cells

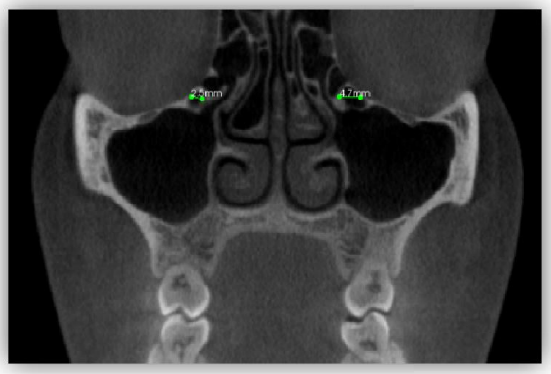


Figure 1. Size of Haller's cells were measured by measuring the maximum mesiodistal diameter on coronal slices of CBCT scans

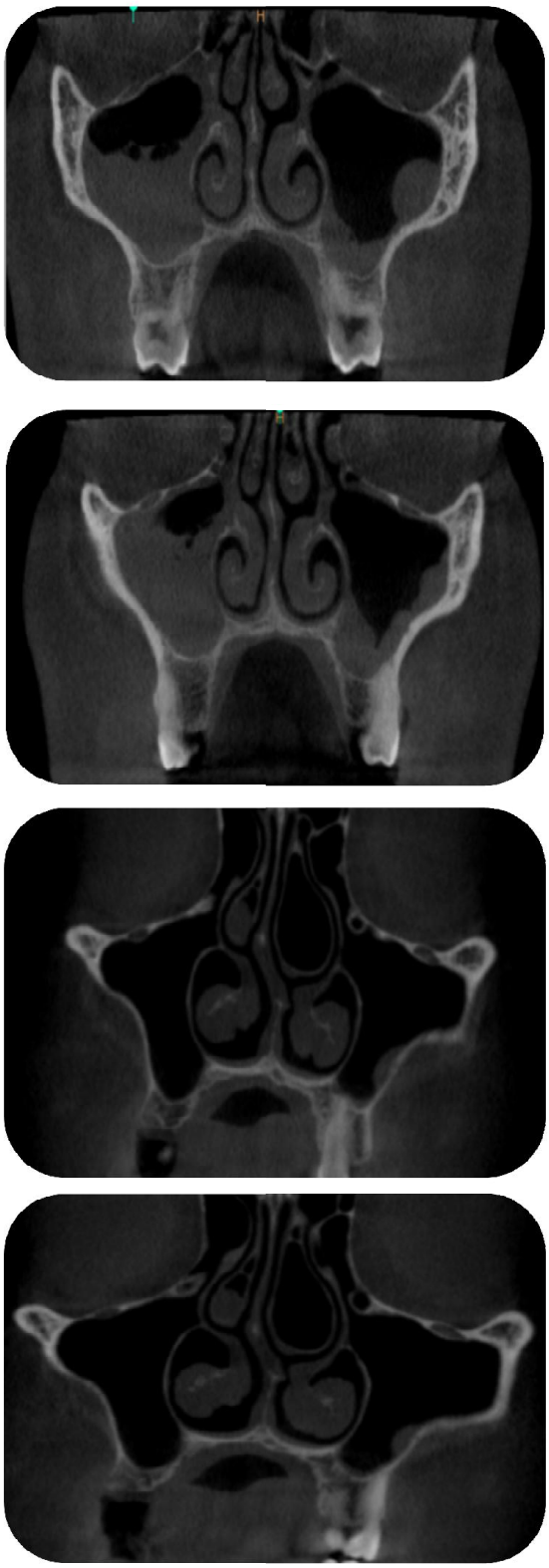


Figure 2. 2 a: partial opacification with right maxillary sinus. Mucosal polyp at lateral wall with left maxillary sinus. 2 b : partial opacification with right maxillary sinus.Mucosal polyp on lateral wall and mucosal thickening at the floor of maxillary sinus with left maxillary sinus 2 c: left side medium size haller's cells with mucosal polyp at lateral wall of left maxillary sinus. 2 d: right and left side medium size haller's cells with mucosal polyp at lateral wall of left maxillary sinus

Bilateral Haller's cells shows significant correlation with presence of Haller's cells and maxillary sinus pathologies, nasal septum deviation, orbital dehiscence with P - 0.004, 0.02, 0.040 respectively (Table 2). 23 medium size of Haller's cells (2.3-4.0mm) shows maximum number of pathologies.12 small

size of Haller's cells (1.5-2.2mm) shows maximum number of pathologies with P - 0.02. The different sizes of Haller's cells were then evaluated for individual pathologies like mucosal thickening, mucosal polyp, polypoidal thickening, opacification. The 45 scans with presence of Haller's cells were then checked for presence of pathologies it showed 26 scans (57.7%) with presence of pathologies and 19(42.2%) without pathologies (Graph, 2). 12 medium size Haller's cells (2.3-4.0mm) shows significant correlation with mucosal thickening with p - 0.03 (Table 3).

DISCUSSION

Since the introduction of CBCT for dentomaxillofacial imaging in 2001, a 3 dimensional imaging modality mostly used for dental implants. It generates high resolution isotropic volume data and could therefore show benefits for evaluating the bony aspects of the maxillary sinus by using a lower dose. Complex radiological anatomy of nose and paranasal sinus can very well be viewed in CBCT. As per review of literature since (1987-2014) the prevalence of Haller's cells varies from 4.7% -62%. In our study the prevalence of Haler, s cells is 78%. This vast difference of Haller's cells may depend upon the criteria for defining Haller's cells, and the imaging modality used. Many Haller's cells studies were conducted on Panaromic and CT (Wanamaker *et al*., 1996). On Panaromic Haller's cells even if present can get superimposed by nasal bones and the mucosal pathologies cannot be well appreciated (Ahmed *et al*., 2006). CT provides higher contrast images compared with CBCT presenting more information of mucosal pathologies but on the other hand smaller size haller's cells can be missed out between the slices. CBCT gives better better visualization of Haller's cells. Sizes of less than 1.5 mm can also be visualised. Mathew *et al* conducted the first CBCT of Haller's cells with the prevalence of 60%. Khojastepour *et al* reported a prevalence of 68% (Mathew *et al*., 2013 and Khojastepour *et al*., 2015). The male to female ratio in our study is 20 male (44%): 25 females (56%). The Unilateral and bilateral distribution shows 17(37%), 28(62%) respectively whereas In Khojastepour study unilateral (34.03%) and bilateral (65.97%) similar to our study.

Regarding relationship between medium and large size bilateral Haller's cells and maxillary mucosal pathologies. There was a significant correlation between medium and large size Haller's cells with maxillary sinus pathologies (Table 3). On review of the studies conducted, we found that there are mixed significant results Mathew *et al* and Khojastepour *et al* did not show any significant relationship between presence of Haller's cells and Maxillary mucosal pathologies whereas Stackpole *et al*, found statistically significant increase in maxillary sinus mucosal disease in patients with medium or large Haller's cells (Braun *et al*., 2003). Fadda *et al* also found that there was a statistically significance between right Haller's cell and ipsilateral maxillary sinusitis, left Haller's cell and left maxillary sinusitis and bilateral Haller's cell and bilateral maxillary sinusitis and implicated as a possible etiologic factor in recurrent maxillary sinusitis due to blockage of the osteomeateal complex (Kantarci *et al*., 2004). The exact etiology is still unclear but the most possibility thought of is that the Haller's cells which are located at the maxillary ostium. Larger Haller's cells causing narrowing of maxillary ostium and Restrict the drainage pathway causing nasal obstruction, and blockage of transmission of fluid, impaired nasal breathing, Pressure headache (Hammad *et al*., 2012). orofacial pain., Increasing the risk of maxillary sinus mucosal diseases. Further we divided maxillary mucosal pathologies into 4 broad categories: mucosal thickening, mucosal polyp, polypoidal thickening, opacification. It was seen that medium and large size Haller's cells have significant relationship with mucosal thickening (Table 3).

In our study we found some scans with presence of maxillary sinus pathologies and no haller's cells and the reason for this finding can be the other anatomical variation of osteomeatal complex. There are studies with association of large sized Haller's cells with nasal septum deviation. In our study there were cases with bilateral presence of Haller's cells associated with nasal septum deviation and was statistically significant. (Table 2). Larger size haller's cells present unilateral shows nasal septum deviation to contralateral side while some cases of smaller size Haller's cells also shows nasal septum deviation this finding concludes that not only Haller's cells but anatomical variation of other parts of osteomeatal complex can cause nasal septum deviation. Orbital dehiscence was also noted in our study which involved large and medium sized Haller's cells (Table 2). The orbital floor dehiscence makes the orbit more vulnerable for secondary inflammation of Haller's cells and orbital oedema and Complication during sinus endoscopic surgery. Sebrechts *et al* have observed in their study that Haller's cells inflammation can be cause of orbital edema (Luxenberger *et al*., 1999).

Limitation of the study

The nature of fluid could not be identified as blood, pus appears radiologically identical. Pathological problems and symptoms associated with these cells has not been evaluated. Other anatomical variation of osteomeatal complex were not considered for the cause of maxillary sinus pathology.

Conclusion

We conclude that Haller's cells was remarkably high. It can be considered as an important contributing factor for maxillary sinusitis. Haller's cells may also be one of the factor which can cause nasal septum deviation along with associated bony abnormalities. Haller's cells are best viewed on CBCT images. CBCT imaging can further be used as a imaging modality for preoperative bony structure evaluation for endoscopic sinus surgery. It has Advantages over CT like LOW dose, has greater sensitivity in detection of small delicate bony structures compared to CT. Further studies regarding Presence of Haller's cells associated with patient giving sinus symptoms and orofacial pain, presence of Haller's cells and its correlation with individual pathologies, Size of maxillary ostium due to Haller's cells present at junction and its co rrelation with maxillary sinus mucosal diseases is recommended and also consideration of osteomeatal complex with regards to sinus pathologies is recommended and needs to be investigated.

Conflicts of interest: Nil.

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