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Haller cell evaluation on CBCT and its relationship to maxillary sinus pathologies

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Abstract
Objective: The goal of this study was to determine the prevalence of Haller cells and assess the link between Haller cell presence and maxillary sinus disorders.
Materials and Methods: 400 patients' cone beam computed tomography (CBCT) image volumes were collected from a Planmeca ProMax 3D mid machine and analysed in the coronal section with a slice thickness of 4 mm using Romex 3.1 software. Haller cells and maxillary sinus illness were investigated at 800 sites in total. Mathew *et al*. provided criteria for identifying Haller cells. For statistical analysis, the data was subjected to the Chi Square test and the Cohen' kappa test, with P values of < 0.05 regarded as statistically significant.
Results: Haller cells were found at 258 of the 800 sites studied, with a frequency of 32.25 %. A total of 288 locations with maxillary sinus disease were found, with 136 of these being linked to Haller cells. A total of 100 sites exhibited maxillary sinusitis in combination with Haller cells, while 36 sites reported a benign mucosal cyst.
Conclusion: In maxillary sinus diseases, Haller cells should be regarded as a significant anatomical variation.

Keywords: CBCT, haller cells, maxillary sinus diseases

Introduction
The structural variation in paranasal sinuses known as Haller cells was named after anatomist Albert Von Haller, who first described this ethmoid pneumatization of the orbital floor in 1765 [1, 2]. Haller cells are an anterior extension of the ethmoidal sinuses into the orbital floor or superior portion of the maxillary sinus, found medial to the infraorbital canal and lateral to the nasolacrimal duct. Orbito Ethmoidal cells and maxillo ethmoidal cells are other names for these cells [1, 3]. Ethmoidal cell posterior extension is uncommon and should be distinguished from lateral extension of the posterior region of the middle meatus [4]. Haller cells do not represent a pathological condition in and of themselves, but they can be the source of patient symptoms. Large Haller cells can compress the infundibulum of the maxillary sinus, obstructing mucociliary movement and causing fluid stagnation. This creates an ideal environment for bacterial development, contributing to maxillary sinus infections. Orofacial pain, persistent sinogenic headache, and orbital edoema are all disorders that Haller cells may play a role in [4].
Few studies have shown a link between Haller cells and maxillary sinusitis in the past, but complete evaluation of Haller cells and entire sinus disease utilising three-dimensional imaging is lacking. In this study, we want to see how common Haller cells are on cone beam computed tomography (CBCT) and how they relate to maxillary sinus illness.

Materials and Methods
400 CBCT scans of patients were obtained with a Planmeca Promax 3D mid machine (Planmeca OY, Asentajankatu 60080 Helsinki, Finland) and analysed with Planmeca Romex 3.2R software in a retrospective analysis. All scans were taken with complaints of temporomandibular joint, orthodontics, dental implants, and other maxillofacial indications, from which scans showing the complete maxilla extending from alveolar bone to the orbit (full face scan and 90 mm maxilla scans) were included in the study, and scans distorted due to artefact, as well as scans not clearly showing the area of interest were excluded. We performed scans on male and female patients above the age of 16 years old [5].
Patients' information, such as age, sex, presence of Haller cells (location, size, quantity), and presence of maxillary sinus pathology, were entered into a specifically created proforma (site, unilateral, bilateral). The institutional ethical committee gave its approval to the study. Random scans were chosen based on inclusion and exclusion criteria, and the results were interpreted as follows:
Mathew *et al* (2013) defined Haller cells as air-filled cavities found medially on the orbital floor and/or lamina papyracea, inferior to the bulla ethmoidalis (large ethmoidal cell). The ethmoidal capsule surrounds Haller cells, distinguishing them from the infraorbital recess of the maxillary sinus. Haller cells come in a variety of sizes and shapes, can be found unilaterally or bilaterally, and can be single or multiple in number. According to Parks ET [6], all maxillary sinus diseases were discovered and diagnosed, including maxillary sinusitis, mucus retention cysts, fluid accumulation, and calcification. All observations were carried out in the coronal portion of the CBCT, with slice thickness of 0.4 mm.
The Chi square test was used to determine the relationship between Haller cells and maxillary sinusitis. Interobserver agreement was determined using Cohen's kappa test. Statistical significance was defined as a P value of < 0.05.

Results

There were 800 locations tested for the presence of Haller cells and maxillary sinus disease out of 400 CBCT scans of patients, with 69 % (276) being male and 31 % (124) being female. Patients ranged in age from 16 to 73 years old (mean age 35 years). The prevalence of Haller cells in the research population was found to be 49.5% (198 of 400). The male to female ratio was 1.05:1 (52.89% male and 49.93% female). There was no statistically significant relationship between the presence of Haller cells and the patient's gender ($P > 0.05$). Haller cells were more prevalent in the 16-25 year old age group (30.23%; 78).

A total of 188 sites were found to have maxillary sinusitis, with 100 (38.75%) of those sites having Haller cells. It was most commonly found in patients with medium and large Haller cells. [Table 1] Chi square test revealed a statistically significant connection with maxillary sinusitis ($P < 0.05$). Mucus retention cysts were found in 100 cases, with 36 (13.95%) of them being linked to Haller cells. Mucus retention cyst had no statistically significant correlation ($P > 0.05$) [Table 1]. Cohen's kappa indicates nearly perfect agreement between two research observers.

Table 1: Correlation of the Haller cells with maxillary sinusitis and mucus retention cyst

	Maxillary sinusitis present	**Maxillary sinusitis absent**	**Total sites**	**$\chi 2$**	**P value**
Haller cells present	100	158	258	22.875	0.0001
Haller cells absent	88	454	542		
Total sites	188	612	800		
	Mucus retention cyst present	**Mucus retention cyst absent**	**Total sites**	**$\chi 2$**	**P value**
Haller cells present	36	222	258	0.3735	0.4817
Haller cells absent	64	478	542		
Total sites	100	700	800		

Discussion

Haller cells are structural changes in the paranasal sinuses that can be found in conjunction with other osteomeatal complex anatomical variants such as concha bullosa, deviated nasal septum, and maxillary sinus septa. The proportion of Haller cells ranged from 2.5 % to 45.1 %. The imaging modality employed to view Haller cells is responsible for the variation in prevalence. We observed a prevalence of 49.5 % in our study, which is greater than other studies' findings. Because CBCT is an advanced imaging technique, it allows us to identify Haller cells with a thickness of less than 0.4 mm, allowing us to identify Haller cells with a diameter of less than 1 mm. This fluctuation could also be ascribed to the difference in sample size, age group, and race.

In this study, we looked at how Haller cells differed by age, gender, location, quantity, size, and shape. Haller cells were more common in younger people than in elderly people. This finding was similar to that of Raina *et al* [7] and Kantarci *et al* [8] could be due to the fact that the majority of the patients in the study were under the age of 25, and there were fewer older individuals. There was no significant relationship between the prevalence of Haller cells and the subjects' gender, which is consistent with Raina *et al* [7] and Basic *et al* [9]. We identified Haller cells on the right side in our work, and Ahmed *et al* [1] and Raina *et al* [7] found the same thing, however Khayam *et al*. and Mathew *et al* [10] found more bilateral Haller cells, contradicting our findings. This discrepancy can be explained by the different sample sizes used in the study. According to size and shape, our study found more medium-sized (2-4 mm) and oval-shaped Haller cells, whereas Mathew *et al*. found more large-sized (>4 mm) Haller cells [10].

Haller cell treatment ranges from conservative to more definitive approaches, such as surgical therapy. Medical therapy can be recommended first in cases where Haller cells are suspected of being the cause of maxillary sinusitis; if that fails, surgical therapy, such as the functional endoscopic approach [4] or the lateral rhinotomy approach [11], can be used to relieve the patient's symptoms. With a larger sample size and better study design, such as longterm prospective studies, the role of Haller cells in producing maxillary sinus diseases could be highlighted.

Conclusion

In our research, the presence of Haller cells and their size were linked to maxillary sinus disease. Without any noteworthy findings on physical examination or endoscopy, Haller cells may be considered as a cause of recurrent or chronic sinusitis. CBCT adds a third dimension to imaging these Haller cells, allowing for the most accurate evaluation and therapy of various sinus diseases.

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