

Investigating Haller Cells and its Relationship with the Increase in the Thickness of the Maxillary Sinus Mucosa Using CBCT in a Patient Referred to the Oral, Maxillofacial Radiology Clinic

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Abstract

Introduction: Due to the fact that the prevalence of Haller's cells had not been investigated in Kashan city, this study aims to investigate the prevalence of Haller's cells and its relationship with the increase in the thickness of the maxillary sinus mucosa in patients referred to a private oral, maxillofacial radiology clinic in city of Kashan Done.

Materials and Methods: This descriptive-analytical study is based on 183 images taken using cone beam tomography (CBCT) imaging of patients who have referred to a specialized clinic for surgery on impacted wisdom teeth, examination of maxillary sinuses, and implantation in the maxilla were done. The images were checked for the presence and absence of Haller cells and the thickness of the maxillary sinus mucosa. The results were entered into the SPSS22 software and analyzed and statistically analyzed. The descriptive characteristics of the samples were determined using central and dispersion indices (mean-index deviation-frequency). To perform analytical analysis Chi Square test and Fisher test were used if necessary, and $P < 0.05$ was considered significant.

Findings: According to the present study, the prevalence of Haller cells was reported to be 72%, and 89.5% of Haller cells were bilateral and 10.5% of them were unilateral. A significant relationship was observed between the prevalence of Haller's cell and gender, and more cases were related to women. However, there was no significant relationship between the prevalence of Haller cells and age. The prevalence of maxillary sinus mucus thickness (sinusitis) was reported to be 79%, and a significant relationship between the prevalence of Haller cells and the increase in maxillary sinus mucus thickness was observed, so that in 84% of samples with Haller cells, an increase in maxillary sinus mucus thickness was observed.

Conclusion: In the studied population, Haller's cell had a high prevalence, which was bilateral in most cases. According to the present study, a significant relationship was observed between the prevalence of Haller's cells and the increase in the thickness of the maxillary sinus mucosa, and the presence of Haller's cells along with its variations can be reported as one of the causes of sinusitis.

Keywords: Haller Cell; Maxillary Sinus; Sinusitis; CBCT

Introduction

One of the problems that surgeons face during mouth, jaw and face operations is the existence of different anatomies in different patients in this area. Haller's cells are one of these things that exist in the paranasal and nasal regions, which cause some symptoms in some diseases such as sinusitis [1]. Ethmoid cells that are spread on the floor of the orbit or on the roof of the maxillary sinus are known as Haller cells. Infraorbital ethmoid air cells (Haller cells) are pneumaticized air cells that are extended along the lamina papyracea and under the ethmoid bulla and in the lateral uncinat process. These cells often originate from the anterior cells of the ethmoid and are located in the vicinity of the infundibulum [15,16].

Haller cells are discovered randomly in paranasal CT scans, and their prevalence in CT scan examinations has been expressed in different percentages in many articles. The location of Haller cells can disturb the normal mucociliary flow and cause recurrent sinusitis [2].

In one study, Haller cells were shown to be unilateral and bilateral. The presence of Haller's cell alone does not cause disease, but its expansion can cause narrowing of the infundibulum and maxillary sinus bone and show symptoms such as nasal obstruction, sinusitis, nasal breathing disorder, headache, chronic cough, and mucocoele. Haller cells can limit access to maxillary sinus or anterior ethmoid cells during endonasal procedures [3,4].

The maxillary sinus is located in the trunk of the maxillary bone and is one of the large paranasal sinuses [5]. Examination of the maxillary sinus has always been of interest to otolaryngologists, maxillofacial surgeons, and dental and maxillofacial radiologists due to its connection with the maxillary teeth, nose, and airway [5]. The maxillary sinus is covered by Schneiderian membrane, whose normal thickness is reported to be about 1 mm. In the presence of inflammatory factors, it has increased in thickness, it has also been stated that a thickness of more than 2 mm indicates maxillary sinusitis [6].

Sinusitis is one of the common problems that can be shown as a toothache, so it is important for dentists to pay attention to this issue before taking any action for dental treatments [7]. Haller cells can block the drainage of the sinuses and play a role in sinusitis, therefore, knowledge about the presence or absence of Haller cells and the thickness of the mucosa of the maxillary sinus is important due to their relationship with sinusitis [4,6,8]. Haller cells can also cause recurrent or chronic sinusitis [9].

Haller cells are clinically important [10]. The expansion of Haller cells can cause narrowing of the infundibulum and disruption of the airway as well as sinusitis. Due to the high prevalence of sinusitis and the effect of Haller cells in sinusitis, it is important to investigate and diagnose it [4,7,11].

Since most of the studies conducted up to now are based on panoramic imaging and this type of imaging is associated with the limitation of two-dimensional images and the lack of showing details in the buccolingual dimensions, the use of cone beam computed tomography (CBCT) is used because of the three-dimensional image display and Anatomical structures with more details and lower radiation dose are beneficial compared to CT scan [13]. Cone ray computed tomography is a relatively new technology that was first introduced in 1982 for the purposes of angiography and then suggested for head and face imaging. A software program along with complex algorithms is applied to these images and three-dimensional volume data sets are obtained which can be used to prepare images in three axial, sagittal and coronal planes [14].

The prevalence of Haller cells in a study conducted on 201 CBCT images was as follows:

- Haller cell prevalence percentage: 36.3%.
- Prevalence percentage of right sided Haller's cell: 32.9%.
- Prevalence percentage of left sided Haller's cell: 23.3%.
- Bilateral Haller cell prevalence: 43.8% [10].

In the studies conducted in relation to Haller cells, CBCT images were chosen due to their much higher accuracy than panoramic images and lower radiation dose than CT scan [8].

Also, various studies have been conducted in connection with the investigation of the prevalence of Haller and its relationship with the increase in the thickness of sinus mucus, as well as its relationship with other diseases in tomographic images; In 2023, Mushfaghi, *et al.* conducted a study with the aim of investigating the prevalence of Haller's cell and its relationship with orbital floor opening using CBCT images.

The overall prevalence of Haller's cells was 56/7%, of which 44 cases (64/7%) were unilateral and 24 cases were bilateral (35/3%). Most of the cells (70.7%) were seen in medium sizes (2 to 4 mm). There was a significant relationship between Haller cells and orbital floor opening [1].

Moridi, *et al.* conducted a study in 2020 with the aim of investigating the prevalence of Haller cells with the help of cone beam computer imaging. Their results showed that significantly more orbital floor opening was observed in patients who had hallucinogens. There was no significant relationship between the presence of hallucinogens and maxillary sinus thickening.

Haller cells can increase the possibility of damage to the orbit, especially during the use of surgical instruments. Therefore, a full evaluation of the bone structure before the operation is necessary to know the exact anatomy of the paranasal sinuses [18].

Patil, *et al.* conducted a study in 2023 to investigate the prevalence of Haller cells in cone beam computed tomography. For this purpose, a number of 139 CBCT images were examined and the researchers concluded that Haller cell has a relatively high prevalence and should be taken into account [19].

In 2022, Mahapatra, *et al.* conducted a study to investigate the frequency and volume of Haller cells and the prevalence of submaxillary osteomyelitis in CBCT images. By conducting this study, they found out that it is necessary for surgeons to be aware of Haller's cell and sub-osteum of the maxilla before surgery [20].

Yadav, *et al.* conducted a study in 2022 to investigate the appearance of Haller cells in panoramic images and its correlation with clinical examinations. The researchers found that although the appearance of the Haller cell can be affected by the inflammation of the osteometal complex, for a better result, a larger population should be investigated [21].

In 2021, Oscan, *et al.* conducted a study aimed at investigating the prevalence of Haller cells and its relationship with submaxillary osteomyelitis (AMO) in the presence of sinusitis. By conducting this study, they found that Haller's cells alone are not a pathological factor for the maxillary sinus, but it can be a predisposing factor [12].

Adaki, *et al.* in 2021 conducted a study aimed at investigating the prevalence of Haller cells in panoramic images. This study included 860 patients of both sexes with an age range of 18 to 60 years. The results of this study showed that panoramic radiography can clearly depict the isolation of Haller cells. The description of Haller's cells is useful in identifying generals and helps in the differential diagnosis of patients with oral pain [22].

Due to the importance of the presence of Haller cells and the increase in the thickness of the mucosa of the maxillary sinus and their relationship with diseases such as sinusitis, headache, shortness of breath, etc., for diagnosis, prevention and treatment, and because the prevalence of Haller cells in Kashan city has not been investigated.

Aim of the Study

This study aimed to investigate the prevalence of Haller's cells and its relationship with the increase in the thickness of the sinus mucosa in patients referred to a private oral, maxillofacial, and facial radiology clinic in Kashan city.

Materials and Methods

The present study was a cross-sectional study. The statistical population of the research was all the clients who had referred to the specialized oral, maxillofacial radiology clinic with a CBCT stereotype, who had gone to perform wisdom teeth surgery, check the maxillary sinuses, and implant in the upper jaw. Based on the survey, the stereotype of 602 people was investigated. Out of all these cases, the stereotype of 419 people was excluded from the study due to reasons such as the lack of sufficient diagnostic quality in the images and lack of visibility of the orbit. Also, patients with a history of sinus surgeries, syndromes and anomalies that cause changes in the structure of the face and sinuses were excluded from the study. A total of 183 stereotypes were eligible to enter the study and were analyzed. All CBCT radiographs were prepared by Planmeca promax device (field of view 80*100 mm) and planmeca romexis viewer software in a private maxillofacial radiology clinic.

At first, each stereotype was assigned a specific number, then the total number of stereotypes was divided by the number of samples (109). The result of this division was considered as the sampling interval. Then a number was randomly selected between the number 1 and the spacing number of the samples and the first sample was the chosen number. Then the space number was added to that number and the next samples were selected in the same way.

After noting the individual characteristics of the patients, including gender and age, the desired images were checked for the presence or absence of Haller cells according to the characteristics.

The studied subjects were divided into groups according to age: under 20 years, 20 - 29 years, 30 - 39 years, 40 - 49 years, and over 50 years.

If Haller cells are present, the characteristics of these cells, including the side of involvement (right and left), whether it is unilateral or bilateral, were recorded.

Patients who had increased mucosal thickness in at least one of the maxillary sinuses were recorded in the data collection form.

Other sinus diseases such as: partial or complete opacification of the sinus, presence of mucocoele or retention cyst, etc. were also included.

The desired images were evaluated under the supervision of an oral, maxillofacial, and facial radiologist with at least one year of practical experience, and any ambiguity in the interpretation was resolved through consultation.

After complete data collection, the resulting data were entered into SPSS 22 software, the descriptive characteristics of the samples were determined using central and dispersion indices (mean-standard deviation-percentage frequency). Chi Square and Fisher test were used if necessary. The significance level was considered to be $P < 0.05$.

Results

Descriptive findings

In table 1, the descriptive information of the sample people and the investigated stereotypes are stated.

Gender	Relative abundance(people)	Relative abundance percentage%	
Female	155	84/7	
male	28	15/3	
The existence of Hall cell	Relative abundance (image)	Relative abundance percentage%	ci(95%)
Observation	133	72%	65-78
Lack of observation	50	28%	21-34
Increase in the thickness of maxillary sinus mucosa	Relative abundance (image)	Relative abundance percentage%	CI(95%)
More than 2 mm	144	79%	72-84
Less than 2 mm	39	21%	15-27
Direction of haller cell	Relative abundance (image)	Relative abundance percentage%	
Two way	119	89.5	
One way	14	10.5	
	133	100	

Table 1: Distribution of demographic characteristics of study participants.

Regarding the prevalence of Haller cells by gender, the prevalence of Haller cells in women was 77% (83%-70% CI; 95%) and 46% in men (28%-64% CI; 95% CI). Based on the analysis of the findings, a significant relationship was observed between the prevalence of cholera and gender, and more cases were related to women $P < 0.05$ (Table 2).

gender	Prevalence	CI(95%)	P value
Female	77	70-83	P=0/001
Male	46	28-64	P=0/001

Table 2: Frequency of Hallersel in women and men.

The average age of the study subjects was 43.18 ± 15.26 years; that no statistically significant difference was observed between the age of people in the studied age groups and the presence and absence of Haller cells (Table 3).

age categories	Prevalence of haller cell	CI(95%)	P value
<20	92	60-99	0/398
20-29	73	49-88	0/398
30-39	66	51-78	0/398
40-49	75	59-86	0/398
>50	70	57-80	0/398

Table 3: Frequency of Hallersel according to age groups.

Based on the obtained results and also based on the chi square test, people who had Haller's cells significantly had a chance of increasing the thickness of the maxillary sinus mucosa (sinusitis). P-Value < 0.05 (Table 4).

Increase in sinus thickness	Observation of haller cell	Lack of observation haller cell	Total	P-value
More than 2 mm	111	33	144	P=0.001
Less than 2 mm	22	17	39	P=0.001
Total	133	50	183	

Table 4: The relationship between the presence of Haller's tuberculosis and the increase in the thickness of the mucosa of the maxillary sinus.

Discussion

Oral pain and sinusitis is one of the important problems that worries patients and is a concern for dentists. These problems can sometimes be related to the presence of Haller cells. Although anatomical changes in the development of the nose and paranasal sinuses, such as Haller's cells, are not a disease in themselves, but in many cases, they increase the chance and probability of symptoms in the patient [18].

Based on the investigations, most of the studies up to now have been based on panoramic images [18].

However, two-dimensional imaging methods, including panoramic, are not able to show the cross-sections of the bone (buccal and lingual). [Cone Beam Computed Tomography (CBCT)] provides us with detailed three-dimensional information about oral structures and does not have the limitations that we face in panoramic images [18,24].

A study was conducted to investigate the prevalence of Haller's cell and its relationship with the increase in the thickness of maxillary sinus mucosa in patients referred to oral, maxillofacial radiology clinic in Kashan city.

To conduct this study, 183 CBCT images were examined, and in the results of this study, the prevalence of cholera was reported as 72%.

The studies of Mushfaqi, Patil, Khojastepour, Mahapatra and Sakhdri reported the prevalence of Haller cells as 56.7%, 52.52%, 68%, 28% and 33%, respectively [1,16,19,20,25].

The observed differences in the report of Haller cell prevalence in different studies can be attributed to reasons such as the study method (imaging type), demographic and racial differences, and the age groups studied. CBCT stereotypes were used in the present study, which has a very high accuracy for diagnosing and differentiating anatomical variations and inflammatory diseases of the nasal cavity and sinuses.

In the present study, a significant relationship was observed between the prevalence of Haller's cell and gender, and more cases were related to women.

In the study of Davoudi., *et al.* a significant relationship between the prevalence of Haller cells and gender was also expressed. [26] that the results of the mentioned study are consistent with the present study.

In the study of Mushfaghi, Yadav and Sakhdri, no significant relationship was observed between the prevalence of Haller's cell and gender [1,16,21].

The difference between the aforementioned studies and the present study can be attributed to the type of technique investigated and the geographical population studied.

In the present study, no statistically significant difference was observed between the presence and absence of Haller cells and the age of the subjects.

In the study of Mushfaqi and Shukhari, no significant relationship was observed between age and the prevalence of Haller's cell [1,27] that the results of the mentioned studies are similar to the conducted study.

In Meridi's study and Sakhdri's study, a significant statistical difference was observed between the prevalence of Haller's cell and age [16,18].

The difference in the results of these studies can be attributed to the difference in the study method and the study population.

Among 133 CBCT images with Haller cells, the frequency of Haller cells was reported more bilaterally.

In the study of Khojstepour and Oskan, the frequency of Haller cells was higher bilaterally [12,25].

However, in their studies, Mushfaghi and Muridi reported the frequency of Haller cells more unilaterally [18,25].

The difference in the results of these studies with the present study can be related to the difference in the type of imaging as well as the difference in the geographical population under study.

In the present study, among the 183 examined images, the frequency of increased maxillary sinus mucosa thickness was 79%.

In their study, Akhter and Khojastepour stated the frequency of increase in the thickness of maxillary sinus mucosa (sinusitis) was 81.7% and 60.7%, respectively [25,28].

However, in Bijani's study, the frequency of increasing the thickness of the maxillary sinus mucosa was reported to be 47% [17].

The difference in the prevalence rate reported in different studies can be related to the statistical population studied, the type of imaging. Also, he knew a different definition of sinusitis (in the current study, the normal thickness of the sinus mucosa was considered to be 2 mm).

Based on the obtained results, people who had Haller's cells had a significantly higher chance of increasing the thickness of the maxillary sinus mucosa.

Valenzuela and Kamdi reported in their study that there is a relationship between the presence of Haller cells and thickening of the maxillary sinus mucosa [23,29]. The results of the mentioned study are consistent with the results of the present study.

However, Moridi and Bijani did not report a significant relationship between the presence of cholera and the thickening of the maxillary sinus mucosa by conducting their own study [17,18].

One of the reasons for the difference in the results of studies can be related to demographic and racial differences as well as different definitions of Haller cells. Although Haller cells are considered to be the cells that are formed by the expansion of the anterior ethmoid air cells in the floor of the orbit and in the upper part of the maxillary sinus, different definitions have been expressed in different studies based on the location of this cell.

Conclusion

In the studied population, Haller's cell had a high prevalence, and most of the cases were bilateral. According to the present study, a significant relationship was observed between the prevalence of Haller's cells and the increase in the thickness of the mucosa of the maxillary sinus (sinusitis). Based on the results of the present study, the presence of Haller cells along with its anatomical variations can be considered as one of the important and significant predisposing factors in increasing the thickness of maxillary sinus mucosa, followed by sinusitis. It should be noted that the findings of this research cannot be generalized to other populations, so it is suggested to conduct a similar study in a different geographical population.

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