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Research Article

Infra Orbital Ethmoid (Haller) Cells: A Cone Beam Computed Tomographic Study in a Population of Iran

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Abstract

Background: The aim of this study was to evaluate the frequency of Haller cells in a population of Iran using Cone beam computed tomography (CBCT) to further identify it as a predisposing factor for sinusitis.

Materials and Methods: In this cross-sectional study, 150 images have been taken from patients over 6 years old using CBCT and all were analyzed at 1 mm sections in axial, coronal and sagittal plans via software available on device (NNTVIEWER). The patients data including age, sex, presence or absence of Haller cells, involved side, the pattern of Haller cells and the shape of Haller cells were determined.

Results: A total of 150 radiographic images obtained by CBCT, were evaluated for the presence of Haller's cells. In current study, the prevalence of infraorbital ethmoid air cells was 58 cases (38.7%) with 30 (51.7%) in females and 28 (48.3%) in males. The sex-dependent correlation was not statistically significant (P = 0.73). The highest prevalence of Haller's cells was observed in people aging 21 - 40 years old with 25 cases (43.1%) but no significant relationship between Haller's cell prevalence and age was found (P = 0.5).

Conclusion: Based on the results of the present study, the use of CBCT imaging can be a helpful diagnostic tool in determination of Haller cells.

Keywords: Cone Beam Computed Tomography; Haller Cell; Infraorbital Ethmoidal Air Cells

Introduction

The paranasal sinuses could guarantee their health state through normal mucosal clearance. The osteomeatal complex (OSC) and paranasal sinuses (PNS) variations such as Haller's cells which disrupt the normal clearance of sinuses eventuate in orofacial complications [1]. The haller's cells (HC) were introduced in 1765 by Albrecht von Haller for first time. These cells are resulted from development of anterior (88%) and posterior (12%) ethmoid sinuses air cells and located on roof of maxillary sinus and on orbital floor which constitutes the inferior orbital wall and infundibulum lateral periphery [2]. Their sites have made them key element in obstruction of ethmoidal infundibulum which results in infection, inflammation, nasal obstruction, headache, impaired nasal breathing and chronic cough [3]. As these cells are placed adjacent to maxillary sinus ostium, they have key position in blockage of ostium and narrowing of infundibulum eventuating to orofacial disease [4]. So that, studies have demonstrated their engagement in rhinosinusitis, allergic rhinitis and sinusitis pathology [5]. In fact, expansion and enlargement of these air cells can cause obstruction of the ethmoidal infundibulum or restriction of access to the anterior ethmoid and maxillary sinuses by which mucociliary flow and fluid transportation disrupts and an optimized environment for microorganism's growth forms [6,7]. As the infections caused only by haller's cells are usually very rare, but various studies have suggested that this type of infection may be suspected in patients with symptoms such as orofacial pain and eyesight problems [8]. According to literatures, the presence of these cells is generally a predisposing factor for recurrent sinusitis. The haller's cell varies in frequency and morphology (shape, size and number) and what's more, they either could be unilaterally or bilaterally [9,10].

It has been reported by different authors that characteristics of haller's cell such as their size and shape could be effective on orofacial afflictions and surgical interventions [10]. As mentioned earlier, pathophysiological importance of these cells is because of their potential in narrowing maxillary sinus ostium and ethmoidal infundibulum, thus, their size, shape and location properties are somehow influencing factors in this context. Though, researches have reported paradoxical findings so that some have suggested relationship between size of haller's cells sinusal headache and sinusitis, while others uncover no distinct correlation between related between them [11,12]. Furthermore, studies have shown that demographic factors such as age and sex might be involved in haller's cell frequency as literatures have indicated that variation of paranasal sinuses occurs in maturity [12,13].

Regarding to significance of haller's cells as a considerable anatomical variation, it is so important to identify these variations for appropriate diagnosis and treatment of disorders via therapeutical approaches like functional endoscopic sinus surgery (FESS) [14]. One of the major problems in obtaining information on paranasal sinuses is not having a favorable radiographic vision. In spite of different technique, there are some drawbacks for each one. The image gained by orthopantomogram (OPG), is often a weak two-dimensional [15,16]. The computed tomography (CT) have some undesirable limitation such as high radiation dose, time delay and artifacts. Moreover, other techniques like endoscopy, Magnetic resonance imaging (MRI) and ultrasonic examination are also used for diagnostic imaging [17,18]. New methods recently have made sectional imaging possible which enable experts to investigate the region of interest.

Today, cone beam computed tomography (CBCT) has provided a new vision in assessing of maxillofacial in dentistry [19]. CBCT uses a rectangular or circular x-ray beam focused on a 2-dimensional x-ray sensor to scan around the patient's head with a 360-degree rotation forming 1 exposure in each degree [20]. CBCT allows the production of instant images not only on the axial plane but also on other two-dimensions; coronal and sagittal, and even oblique [21]. Thus, the raw digital information is finally reconstructed on a volumetric imaging to provide 3D maxillofacial information. Low cost (compared to provided information), High quality image, short time (less than one minute), selecting image of desired section, low dose radiation, detection of defects and asymmetry in skull are some of multiple advantages of CBCT [22]. Hence, this technique could give high quality schematic 3D vision from sinuses, sinusal ducts and their containing cells [23].

Aim of the Study

The aim of this study was therefore to evaluate the frequency of Haller's cells in a population of Iran using cone- CBCT to further identify HC as a sinusitis-predisposing factor. So that we investigated Frequency of these cells depending on sex, age and involved side (Right, Left and Bilateral) and also the frequency of Haller's cells pattern (Single, Multilocular, Multi Pattern) and morphology (round or tear-shape) were determined.

Materials and Methods

Current study is a retrospective cross-sectional study performed from January 2018 to Mars 2019 in a private oral and maxillofacial radiology center, Babol, Iran in which we assessed the 150 paranasal sinus CBCT data obtained from 150 patients (6 years and up) including 69 men and 81 women.

Patients

After studying all patient medical files, patients with following conditions were excluded; patients with diagnosed or suspected neoplastic or traumatic complaints, mid-face surgery intervention.

In addition, radiographic images with unacceptable exposure conditions, arguable quality, artifacts and incorrect patient position were also omitted.

Study design

The CBCT radiographs were taken by Newtom G5 device, Italy. The images were investigated in 3 axial, coronal, and sagittal planes at 1 mm sections using software (NNTVIEWER) available on the device. Moreover, in analysis of each radiographs, the patient sex and age, presence or absence of Haller's cells, involved side, pattern of haller's cells and their morphology were determined, too. Firstly, the images, as common, were assessed in coronal plane followed then by inspection in axial and sagittal planes in order to discriminate haller's cells from bone crests. We assessed HCs tri-dimensionally, as the bone crest often resembles haller's cell in two-dimension graphics or one-plane analysis. Finally, in a volumetric measurement, the volume of found haller's cell as well as its partial volume (the part of cell beneath orbital floor) were measured. Based on the vertical drawn line which crossed the orbital floor at most medial and cranial points, haller's cell partial volume was defined as volume located sidelong to line and adjacent to orbital floor.

Statistical analysis

The data were analyzed using SPSS 20 software by chi-square and Mann Whitney U test. Significant differences were considered P < 0.05.

Results

A total of 150 radiographs performed by CBCT were evaluated for the presence of Haller's cells. Our results revealed presence of infraorbital ethmoid air cells in 58 cases among all (38.7%). Furthermore, we tried to examine the mean size of haller's cells and ostium bone in right and left sides. Our data showed that the mean size of haller's cells on right and left were 4.97 and 4.56 mm, respectively. In addition, the mean size of ostium was calculated 2.30 mm for left and 1.95 mm for right side with no significant difference between two sides (P = 0.1). Also, we found no correlation between two variables mean sizes, Haller's cells and ostium (r = 98.1 and. P = 58.1). Then, the prevalence of Haller's cells among the participants was compared based on gender. So that, among 58 cases with identified HCs, it included 30 females (51.7%) and 28 males (48.3%), but no statistically significant relationship was found between sex and HCs frequency (P = 0.73). We also categorized the patients with HCs into different groups due to their age to divulge age-dependent incidence of these cells. The prevalence of HCs in different age groups was found to have the highest frequency in people with ages 21- 40 (25 cases; 43.1%) and the lowest HCs incidence was related to individuals with 61 years old and up (6 cases; 10.3%). Like gender, no significant interrelationship was observed between age and HCs frequency (P = 0.50).

Variables	Mean ± SD	Min	Max	p. value
Left side Haller's cell	4.56 ± 1.85	2	10	0.1 (ns)
Right side Haller's cell	4.97 ± 1.94	1	10	
Left side ostium	1.95 ± 1.56	0	5	
Right side ostium	2.30 ± 1.84	0	7	

Table 1: Mean size Haller's cells and ostium bone in each side.

Sex	With HCs	Without HCs	p. value
Men	28 (48.3%)	41 (44.6%)	0.73 (ns)
Women	30 (51.7%)	51 (55.4%)	

Table 2: The frequency of HCs in both genders.

Age groups	With HCs	Without HCs	p. value
Less than 20	10 (17.2%)	11 (12%)	0.50 (ns)
21-40	25 (43.1%)	45 (48.9%)	
41-60	17 (29.3%)	31 (33.7%)	
61 and up	6 (10.3%)	5 (5.4%)	

Table 3: The table below displays HCs frequency in different age groups.

In next step, we assessed other variable; sinusal mucus thickness and orbital floor dehiscence (OFD). Here, the aim was to evaluate the correlation between HCs frequency and given variables in different patients in order to elucidate whether there is any interaction relation between HCs presence and sinusal mucus diameter or dehiscent orbital floor. Our findings demonstrated that there was no significant association between thickening of sinus mucosa and people with a radiographic image showing Haller's cell (p = 0.45). qua, individuals with or without HCs had similar thickness in left or right sides. Though unexpectedly, thickened mucos was identified less in patients with HCs compared to those without HCs. Moreover, we did a comparison between Haller's cells presence and orbital floor dehiscence (OFD), and we observed that right side OFD had a significant correlation with HCs existence (p = 0<00.1) which did not occur for left side OFD (p = 0.55). It has been demonstrated that the prevalence of right-side OFD is considerably higher in individual with HCs compared to those with lack of HCs, while left-side OFD was more dominant in people without HCs. In addition, when we examined the size of left and right ostium in patients with and without Haller's cells, we noticed that there was also no significant association between ostium size and Haller's cell presence (P = 0.14), though the size of both left and right ostium were trivially larger in individuals possessing HCs in comparison to patients not possessing HCs.

Thickened mucus	With HCs	Without HCs	p. value
Right	8 (13.8%)	8 (8.7%)	0.45
Left	10 (17.2%)	10 (10.9%)	
Both sides	23 (39.7%)	41 (44.6%)	
None	17 (29.3%)	33 (35.9%)	

Table 4: The relation between HCs presence and sinusal mucus thickness.

OFD		With HCs	Without HCs	p. value
Right	No	18 (31%)	79 (85.9%)	<0.001
	Yes	40 (69%)	13 (14.1%)	
Left	No	35 (60.3%)	51 (55.4%)	0.55
	Yes	23 (39.7%)	41 (44.6%)	

Table 5: The correlation between orbital floor dehiscence (OFD) in left side and HCs presence.

Variables	With HCs	Without HCs	p. value
Right side ostium size	2.20 (1.55)	1.79 (1.55)	0.14
Left side ostium size	2.57 (2.01)	2.13 (1.72)	0.14

Table 6: The relation between ostium sizes and Haller's cells presence in both sides.

Discussion

The controversial pathologic role of haller's cell in some orofacial illnesses, has been investigated in various studies which have resulted in paradoxical data [24]. Nevertheless, infraorbital ethmoidal air cells as anatomical variations, are believed in common to be associated with various orofacial diseases such as sinusitis and rhinitis allergic [25]. Hence, these cells as a risk factor probably seem to be affected by regional and populational differences. what factors might really influence HCs presence, frequency and pathologic role? In recent years, new techniques of radiography including CBCT imaging, have enabled us to obtain more precise knowledge to enhance the scope of radiologists in examination of oral and maxillofacial structures which finally results in diagnosis of any underlying pathologic factor. In spite of CBCT capabilities, searching for evidences indicates that not enough studies have been performed to establish the diagnostic value of CBCT in identification, prevalence determination and characterization of Haller's cells in north part of Iran.

In current study, we assessed the frequency of haller's cell in Iranian population in association with probably influencing factors including age and sex as well as engaged side (in where HCs exist), pattern of haller's cells and their morphology. Studies on the frequency of Haller's cells in different populations of Iran are limited and similar studies in other countries is no longer applicable to Iran due to racial and genetic differences. The genetic mechanisms appear to be most vigorous factor for differences in every clinical aspect [26,27]. The most important finding of the present study is the prevalence of 38.7% of Haller's cells among referred patients in in a private oral and maxillofacial radiology center. This incidence percentage implies that HCs couldn't be the most dominant predisposing factor for orofacial diseases, though it may play an important role. Thus, other accessories such as maxillary sinus ostia that can promote maxillary sinus ventilation, could fairly justify the absence of firm correlation between HCs presence and patients with sinusoidal disorders. In accordance with our data, Ahmad., *et al*. concluded that among of 173 examined CBCT radiographs, the HCs were found in 66 patients (38.2%) [25], but Davoodi., *et al.* reported much lower incidence likely due to more examined radiographs [28]. After analyzing the mean size of HCs and ostium bone in left and right side, it could be suggested that ostium bone did not influence the HCs prevalence, as no clear relationship between size of HCs and ostium bone was found.

Moreover, we also indicated that there was no considerable difference in Haller's cells prevalence between men and women. In a similar study in which Khojastepour., *et al*. assessed the incidence of HCs in patients with sinusoidal symptoms [29], he reported no significant difference for HCs between male (9.8%) and females (12%), the data which was also gained by Yesilova., *et al*. who investigated the occurrence and characteristics of HCs in edentulous patients and found no relationship between gender and HCs frequency [10].

Our results also showed that the highest frequency of HCs existed in 21 - 40 age group (46.7%) without any statistically significant differences making an association between patients age and HCs incidence. In contrary, Ghafari., *et al*. noted highest frequency of Haller's cells was in age groups 20 and 40 - 51 years [30] which is in contradict with present study. It could be suggested that age is a regional and populational-dependent factor, and the genetics mainly determine the correlation between HCs prevalence and age factor. What's more, in present study, Haller's cells occurred 43.1% and 56.9% as bilateral and unilateral patterns, respectively, which bilateral pattern was reported significantly higher in patients. Parallelly, Davoodi., *et al*. [28] and Raina., *et al*. [31] who examined the HCs pattern in patients with orofacial diseases, also demonstrated that most HCs existed significantly in unilateral pattern.

Here, we also observed that HCs are mostly in circular form which were found in 20 cases (34.5%) of all.

These data are in harmony with Nedunchezhian., *et al.* study that mentioned that most of the observed Haller's cells were circular [32]. Though, there is also conflicting data such as Chaudhari., *et al*. who represented most of the Haller's cells observed in the radiographs were in elliptical form [33]. Finally, another notable finding was the association between Haller's cells and orbital floor dehiscence, as most of cases with HCs, had right-side OFD and most patients lacking HCs found not to have both sides OFD, neither. OFD commonly known as loss of orbital bone density loss, enhancing the venerability of orbital floor, is expected to be involved in HCs inflammation. Differences in samples could be accounted for left or right higher incidence. Mathew., *et al*. revealed a significant relationship between Haller's cells and the orbital cavity dehiscence [5]. Interestingly, we also saw that there was not any correlation between sinusal thickened mucus and HCs presence as we expected that HCs trigger thicker mucus leading to sinusal obstruction. Hence, it is suggested that not only HCs, but other factors might be involved in blockage of sinusal ducts and subsequent disorders.

Conclusion

Our data indicated CBCT as a reliable technique for obtaining valuable populational information in maxillofacial studies. Here, we found HCs as age and sex-independent factor. Because, these variables may themselves be affected by geographical factors based different reports in various countries. We elucidated that the size of HCs and osteoma in left or right sides do not affect the HCs frequency and quality. The most impressive findings were that most HCs existed with round shape in unilateral pattern with right-side OFD. All in all, we concluded that there was only significant correlation between OFD and HCs frequency in Iranian population, but doesn't mean that the studied factor absolutely are not involved in HCs frequency and behavior. Hence, these variable be prognostic parameters in other population according regional and genetic differences, so more studies are needed to complete our theories.

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