Frontiers in Dentistry

Correlation between the Opacification Degree of Paranasal Sinuses on CT, Clinical Symptoms and Anatomical Variations of the Nose and Paranasal Sinuses in Patients with Chronic Rhinosinusitis

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Article Info

Article type:
Original Article

Article History:
Received: 22 Feb 2021
Accepted: 29 Jul 2021
Published: 28 Sep 2021

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A B S T R A C T

Objectives: This study aimed to evaluate the correlation between the opacification degree of the paranasal sinuses on computed tomography (CT) with clinical symptoms, and anatomical variations of the nose and paranasal sinuses in patients with chronic rhinosinusitis (CRS).

Materials and Methods: This descriptive prospective study evaluated 100 patients (60 males and 40 females), who were diagnosed with CRS by ENT specialists according to the clinical findings, and were scheduled for a CT scan. The patients were requested to express the severity of their symptoms using a visual analog scale. The CT scans of the paranasal sinuses were assessed for the presence of anatomical variations and scored using the modified Lund-Mackay scoring system for the opacification degree of each sinus. The correlations between the anatomical variations and sinusitis, and also between the severity of symptoms/disease severity and CT scores were statistically analyzed. $P<0.05$ was considered statistically significant.

Results: The most common symptoms were purulent (discolored) nasal drainage and nasal obstruction. Septal deviation was the most common anatomical variation. The maxillary and anterior ethmoid sinuses were the most commonly involved areas. The Spearman's correlation coefficient showed a significant correlation between the sinus involvement and some of the evaluated symptoms, as well as certain types of anatomical variations ($P<0.05$).

Conclusion: Some specific anatomical variations of the paranasal sinuses may predispose them to sinusitis. The CT scan score can predict the severity of many symptoms such as purulent (discolored) nasal drainage, nasal obstruction, hyposmia/anosmia, halitosis, cough, and fatigue, among the other symptoms of CRS.

Keywords: Sinusitis; Tomography, X-Ray Computed; Signs and Symptoms; Anatomical Variation

➢ **Cite this article as:** Niknami M, Emami E, Mozaffari A, Sharifian H, Safari S. Correlation between the Opacification Degree of Paranasal Sinuses on CT, Clinical Symptoms and Anatomical Variations of the Nose and Paranasal Sinuses in Patients with Chronic Rhinosinusitis. *Front Dent*. 2021:18:33.

INTRODUCTION

Chronic rhinosinusitis (CRS) refers to the inflammatory disease of the paranasal sinuses that lasts for at least 12 weeks. It is characterized by sinonasal symptoms, and is confirmed by the presence of a complex of major/minor clinical signs and symptoms. The major criteria include purulent (discolored) anterior or posterior nasal discharge, nasal blockage/obstruction, facial pain/pressure/ congestion, and anosmia/hyposmia; while, minor symptoms may include headache, ear pain/pressure/fullness, halitosis, dental pain, cough, and fatigue [1]. Anomalies found on the computed tomography (CT) scan, including the opacification degree of the sinuses or the ostiomeatal complex (OMC), and endoscopic signs of the middle meatus obstruction support the diagnosis of CRS [2].

Conventionally, CRS is usually secondary to bacterial colonization, as a result of treated but unresolved acute rhinosinusitis (RS). However, this statement may not be accurate, since the most acute cases of RS are found to be caused by viral infections of the respiratory tract, which can often resolve without treatment. The predisposing factors for sinusitis include anatomical variations of the paranasal area, non-allergic and allergic rhinitis, allergic fungal RS, pneumonia, asthma, bronchitis, otitis media, gastro-esophageal reflux disease, adenotonsillitis, sleep apnea, air pollution, smoking, genetic factors, and inherent or acquired immune-deficiency, such as HIV and cystic fibrosis [2,3].

It is reasonable to assume that patients may be more vulnerable to CRS in presence of anatomical variations of the paranasal sinuses. Anatomical variations in the lateral wall of the nasal cavity are specially important, because they can lead to obstruction of the OMC, and consequently increase the risk of developing sinusitis [4]. However, the role of anatomical variations in the severity of symptoms experienced by the patients suffering from CRS is still controversial, and contradictory results have been reported in this respect [4-13].

CT scan is currently the method of choice for assessment of the nose, the paranasal sinuses, and the adjacent structures. This method can help with optimal visualization of air, soft tissue, and bone, and can therefore help with accurate determination of disease severity and extension within and around the paranasal sinuses. It can also reveal the anatomical variations that may predispose patients to RS, as well as the adjacent critical structures, which should be identified in order to avoid iatrogenic injury [14].

The signs and symptoms of CRS are similar to those of other benign sinonasal diseases; therefore, making a diagnosis based on symptoms alone may not be accurate. Also, the symptoms may not sufficiently indicate the involvement of a particular paranasal sinus or the severity of disease [15].

There are various reports on the correlation of the severity of CRS symptoms and CT scan evidence of opacification degree. This correlation, however, remains controversial [16-21]. Considering the severe complications of untreated RS, accurate diagnosis is imperative for appropriate treatment planning and prevention of drug resistance emergence due to unconventional or multiple therapeutic regimens. Concerning the significance of finding accurate clinical diagnostic criteria for CRS, this study was designed as an attempt to enhance the accuracy of clinical diagnosis of CRS and to help with the selection of patients in need of CT scan evaluation. Therefore, the aim of this study was to assess the correlation between the opacification degree of paranasal sinuses on CT scan, and clinical symptoms, and anatomical variations of the nose and paranasal sinuses in patients with CRS.

MATERIALS AND METHODS

This study was performed at the ENT and Radiology Departments of Amiraalam Hospital, Tehran, Iran, and was approved by the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.REC.1394.860). The minimum sample size was calculated to be 98 patients based on a pilot study on 40 patients considering α=0.05, beta=0.2 and e=0.15.

This descriptive prospective study evaluated 100 patients (60 males and 40 females) who were diagnosed with CRS by an ENT specialist and were scheduled for a CT scan. As

recommended by the Rhinosinusitis Task Force, the diagnosis of CRS was made if the patient presented with ≥2 major or one major and two or more minor symptoms based on the CRS-related criteria over a period of 3 months. The major criteria included nasal obstruction or blockage, anterior and/or posterior nasal discharge, facial pain/congestion/pressure, and anosmia/hyposmia; while, the minor criteria included headache, halitosis, ear pain/pressure/fullness, dental pain, cough, and fatigue [1].

Initially, written informed consent was obtained from all patients after providing a complete description of the study. A questionnaire was filled out for each patient via an interview. The patients were asked to provide information regarding their age, history of trauma, medical and surgical history, and smoking status. Patients with asthma, acute rhinosinusitis, sinonasal mass, HIV infection, previous history of sinonasal surgery or facial trauma, age younger than 17 years, and craniofacial anomalies were excluded from the study.

During a clinical visit, the patients were instructed on how to fill out a questionnaire that asked for the Rhinosinusitis Task Force symptoms. The severity of each symptom was scored 1 to 10 using a visual analog scale. Score 10 showed the most severe symptom while score 0 indicated absence of any symptom. Scores 7-10 indicated severe disease, scores 4-6 indicated moderate severity of disease, and scores 1-3 indicated mild disease.

The CT scan of the paranasal sinuses was performed for each patient (SOMATOM Emotion 6-slice CT; Siemens, Munich, Germany) with the exposure settings of 120 kV and 300 mAs with a slice thickness of 2.0 mm, from the frontal sinus to the maxillary sinus floor. Coronal reconstruction of images was then performed.

All CT images were assessed by a general radiologist for the opacification degree of the anterior and posterior ethmoid, sphenoid, frontal, and maxillary sinuses, and presence of normal anatomical variations of the paranasal sinuses (septal deviation, spur formation, bullosa and paradoxical curvature of the middle concha, agger nasi cells, Haller cells, and Onodi cells). According to the University of Miami Chronic Rhinosinusitis Staging System, the modified Lund-MacKay staging system was used, which measures the opacification degree of the paranasal sinuses on CT scans. Each side (right and left) of each paranasal sinus was studied separately. The scoring system was as follows: 0 (normal), 1 (1%-33% opacification), 2 (34%-66% opacification), 3 (67%-99% opacification), and 4 (100% opacification) [22]. The total score was calculated to determine the overall Lund-MacKay score.

Scores ≥1 were considered abnormal. The total score for the severity of symptoms was also calculated. After data collection, SPSS version 24 (SPSS Inc., IL, USA) was used for statistical analysis. The correlation of symptoms with sinus involvement on CT scans, the total symptom severity score, the total CT score, and the correlation of anatomical variations with sinus involvement were analyzed by the Spearman's correlation coefficient. The level of statistical significance was set at $P<0.05$.

RESULTS

A total of 100 patients were enrolled. Of all, 60% were males and 40% were females with a male to female ratio of 1.5. The patients had a mean age of 37.4±9.1 years (range 17-60 years).

All patients presented more than one symptom. The most common symptom was purulent (discolored) anterior or posterior nasal drainage, which was seen in 98 (98%) cases. The second most common symptom was nasal obstruction, observed in 97 (97%) cases followed by headache in 78 (78%) cases. Fever was the least common symptom found in 19 (19%) cases. The mean severity scores for nasal discharge and nasal obstruction were higher while the lowest mean severity scores were noted for fever, dental pain, and ear pain/pressure/fullness.

The overall severity score of the disease was severe/high in 6 (6%) patients; moderate/intermediate in 44 (44%) patients, and mild/low in 50 (50%) patients (Table 1).

Table 1. Percentage of patients with a specific symptom and the mean visual analog scale score for each symptom

Symptoms	Mild (1-3)*	Moderate (4-6)	Severe (7-10)	Patients with symptoms	Patients without symptoms	Mean severity score (0-10)
Purulent (discolored) anterior or posterior nasal drainage	22	28	48	98	2	6.14
Nasal obstruction/blockage	12	28	57	97	3	6.66
Facial pain/pressure/fullness	33	24	15	72	28	3.21
Facial congestion/fullness	22	30	13	65	35	2.96
Hyposmia/anosmia	25	20	29	74	26	4.08
Headache	18	25	35	78	22	4.81
Ear pain/pressure/fullness	17	15	9	41	59	1.89
Halitosis	21	23	20	54	46	2.83
Dental pain	11	9	5	25	75	1.07
Cough	21	10	13	44	56	2.05
Fatigue	28	29	7	65	35	2.65
Fever	16	2	1	19	81	0.52
Total	50	44	6	100	0	3.23

* Parentheses indicate scores

A detailed analysis of the CT scans showed at least one anatomical variation in 99 (99%) patients. Table 2 demonstrates the incidence of variations. The most common anatomical variation was septal deviation (95% of patients) followed by spur formation (53% of patients) and agger nasi cells (44% of patients). The CT scans also indicated that at least one paranasal sinus was involved in all studied patients.

The maxillary sinus was the most commonly involved sinus in 96 patients (186 sides), followed by the anterior ethmoid sinus in 87 patients (162 sides), posterior ethmoid sinus in 62 patients (115 sides), sphenoid in 45 patients (78 sides), and frontal in 42 patients (75 sides). As demonstrated in Table 3, the mean modified Lund Mackay score was 2.79 for the maxillary sinus, 2.52 for the anterior ethmoid sinus, 1.82 for the posterior ethmoid sinus, 1.12 for the sphenoid sinus, and 0.97 for the frontal sinus.

Table 2. Incidence (%) of anatomical variations in the nose and paranasal sinuses

Normal anatomical variation	Unilateral		Bilateral	Total Positive	Total Negative
	Right	Left			
Septal deviation	55	51	11	95	5
Spur formation	32	24	3	53	47
Concha bullosa	22	17	12	27	73
Paradoxical middle concha	6	9	0	15	85
Agger nasi cell	42	40	40	44	56
Haller cell	10	6	3	13	87
Onodi cell	27	13	11	29	71

Table 3. Percentage of patients with a specific sinus opacification and the Lund Mackay mean score for each sinus

Sinus	Opacification degree (%)					Mean score (0-4)
	Score 0 (0)	Score 1 (1-33)	Score 2 (34-66)	Score 3 (67-99)	Score 4 (100)	
Right maxillary	7	68	10	8	7	1.4
Left maxillary	7	64	15	11	3	1.39
Bilateral maxillary	4	55	6	5	2	2.79
Right anterior ethmoid	18	50	23	6	3	1.26
Left anterior ethmoid	20	47	22	9	2	1.26
Bilateral anterior ethmoid	13	42	19	5	2	2.52
Right posterior ethmoid	42	31	22	4	1	0.91
Left posterior ethmoid	43	30	21	5	1	0.91
Bilateral posterior ethmoid	38	28	19	4	1	1.82
Right sphenoid	63	27	4	5	1	0.54
Left sphenoid	59	31	4	5	1	0.58
Bilateral sphenoid	55	22	2	3	0	1.12
Right frontal	62	31	5	2	0	0.47
Left frontal	63	26	9	2	0	0.50
Bilateral frontal	58	23	4	2	0	0.97

Table 4 shows the correlation between the anatomical variations and involvement of the paranasal sinuses in each side. There were statistically significant correlations between the left paradoxical middle concha with the left maxillary sinus (correlation coefficient: 0.297, P=0.006), and the left anterior ethmoid (correlation coefficient: 0.277, P=0.006), and also the left septal deviation and the left Haller cell with the sphenoid sinus (correlation coefficient: 0.233, P=0.02 and correlation coefficient: 0.241, P=0.016, respectively).

There were also statistically significant correlations between the right paradoxical middle concha with the right maxillary sinus (correlation coefficient: 0.466, P<0.001), posterior ethmoid (correlation coefficient: 0.218, P=0.03), sphenoid (correlation coefficient: 0.213, P=0.034), and frontal sinus (correlation coefficient: 0.3, P=0.003) involvement, and right agger nasi cell (correlation coefficient: 0.224, P=0.026) and right Haller cell (correlation coefficient: 0.21, P=0.037) with the right maxillary sinus involvement (P<0.05). The correlation between symptoms and involve-ment of the paranasal sinuses was also analyzed.

The results showed a significant relationship between the maxillary sinus involvement and purulent (discolored) anterior or posterior nasal drainage (correlation coeffi-cient: 0.203, P=0.042), anterior ethmoid sinus involvement and hyposmia/anosmia (correla-tion coefficient: 0.310, P=0.002), posterior ethmoid sinus involvement and nasal obstruction/blockage (correlation coefficient: 0258, P=0.010) and hyposmia/anosmia (correlation coefficient: 0256, P=0.010), sphenoid sinus involvement and halitosis (correlation coefficient: 0.200, P=0.046), and frontal sinus involvement and hyposmia/anosmia (correlation coefficient: 0.257, P=0.010), cough (correlation coefficient: 0.258, P=0.010) and fatigue (correlation coefficient: 0223, P=0.026). There was no significant correlation between facial pain/ pressure/ fullness/ congestion, head-ache, ear pain/ pressure/ fullness, dental pain, or fever with the involvement of paranasal sinuses (Table 5). A statistically significant correlation was found between the total severity score of the symptoms and the total modified Lund-Mackay score (correlation coefficient: 0339, P=0.001).

Table 4. Percentage and association of left and right anatomical variations and sinus involvement (Spearman's correlation coefficient)

Normal variation	Side	Sinus									
		Maxillary		Anterior ethmoid		Posterior ethmoid		Sphenoid		Frontal	
		%	P	%	P	%	P	%	P	%	P
Septal deviation	Left	48	0.894	38	0.935	28	0.962	26	0.020*	23	0.114
	Right	50	0.801	46	0.722	32	0.941	21	0.736	22	0.686
Spur formation	Left	23	0.929	19	0.969	15	0.634	14	0.056	8	0.654
	Right	30	0.283	28	0.497	21	0.545	11	0.822	13	0.779
Concha bullosa	Left	16	0.476	13	0.845	9	0.907	7	0.733	5	0.760
	Right	22	0.469	17	0.763	12	0.818	10	0.302	10	0.233
Paradoxical middle concha	Left	9	0.006*	9	0.006*	8	0.054	5	0.253	4	0.871
	Right	6	0.000*	5	0.064	5	0.030*	4	0.034*	5	0.003*
Agger nasi cell	Left	38	0.340	32	0.359	24	0.856	19	0.640	16	0.919
	Right	37	0.026*	32	0.220	22	0.318	15	0.677	15	0.598
Haller cell	Left	6	0.095	6	0.076	4	0.688	5	0.016*	3	0.497
	Right	9	0.037*	8	0.172	7	0.175	5	0.221	6	0.151
Onodi cell	Left	12	0.947	10	0.665	8	0.691	7	0.197	5	0.839
	Right	26	0.310	21	0.837	16	0.830	11	0.624	12	0.462

Table 5. Percentage and correlation of symptoms with involvement of the paranasal sinuses (Spearman's correlation coefficient)

Symptoms	Sinus									
	Maxillary		Anterior ethmoid		Posterior ethmoid		Sphenoid		Frontal	
	%	P	%	P	%	P	%	P	%	P
Purulent (discolored) anterior or posterior nasal drainage	95	0.042*	86	0.094	62	0.608	44	0.846	41	0.144
Nasal obstruction/blockage	93	0.352	84	0.230	59	0.010*	42	0.606	40	0.162
Facial pain/pressure/fullness	70	0.233	66	0.055	48	0.212	34	0.409	34	0.344
Facial congestion/fullness	64	0.95	58	0.555	43	0.429	30	0.927	31	0.271
Hyposmia/anosmia	73	0.231	69	0.002	51	0.010*	36	0.051	35	0.010*
Headache	76	0.519	69	0.684	49	0.759	35	0.409	31	0.483
Ear pain/pressure/fullness	40	0.505	32	0.093	24	0.797	19	0.880	18	0.791
Halitosis	51	0.531	47	0.402	34	0.961	31	0.046*	23	0.742
Dental pain	25	0.240	21	0.738	14	0.534	10	0.532	8	0.289
Cough	44	0.088	40	0.472	31	0.148	24	0.122	25	0.010*
Fatigue	62	0.986	58	0.847	42	0.257	29	0.862	30	0.026*
Fever	19	0.331	18	0.300	15	0.116	10	0.549	10	0.315

DISCUSSION

Of 100 patients evaluated in this study, 60% were males and 40% were females. This pattern of gender distribution was similar to some previous investigations [17,20,22-24]. We also assessed the possible correlation between the clinical symptoms and sinonasal anatomical variations based on CT scan findings. The sinonasal region has the highest rate of anatomical variations. Knowledge about this relationship can assist in correct diagnosis, proper treatment planning, and selection of patients for CT. The results of similar studies on this topic have been controversial so far [16-21].

In our study, the rate of anatomical variations of the paranasal sinuses was 99%. Several studies have assessed the role of anatomical variations such as septal deviation, nasal septal spur, concha bullosa, OMC closure, agger nasi cell, Haller cell, Onodi cell, and paradoxical middle concha in the development of CRS [4-13]. However, no consensus has been reached on the effect of anatomical variations on CRS incidence. Some researchers believe that changes in ventilation and normal drainage of the sinuses can be a cause of CRS [4-13]. The present study showed that septal deviation, paradoxical middle concha, Haller cell and agger nasi cell were among the predisposing factors for CRS. Table 6 shows the rate of normal anatomical variations in CRS reported by several previous studies.

Nasal septal deviation refers to any septal deviation from the midline. We found a statistically significant relationship between the left septal deviation and left sphenoid sinusitis. Some studies [5,7,9,13,25] revealed septal deviation to be directly correlated with sinusitis, unlike some other studies [4,6,8,12]. If the nasal septal deviation is severe, it can cause pressure on the middle concha and cause narrowing of the middle meatus, resulting in obstruction, secondary inflammation, and infection [11].Nasal spur is an asymptomatic deformity of the nasal septal bone that can restrict the nasal air flow and may be related to septal deviation. As in some other studies, a significant association was not found between this anatomical variation and sinusitis in our study [9,25].

Concha bullosa is a variation that has a negative effect on the ventilation of the sinuses and the mucociliary clearance of the middle meatus. Some studies suggest that subsequent obstruction of the OMC may be an etiological factor in the development of CRS [5,9,13,25]. However, some other studies, including the current study, concluded that there was no significant relationship between concha bullosa and inflammatory sinus disease [4,6,8,10,12]. The term paradoxical middle concha is used when this convexity of the middle concha is in the lateral direction. Paradoxical middle concha is reported to be a potential cause of obstruction of the middle meatus and OMC [26]. In our study, as in the study by Azila et al, [6] this variation had a significant effect on the prevalence of involvement of all sinuses, unlike some other studies [5,8,9,12,25].

The degree of convexity is the most important factor in causing obstruction and subsequent sinusitis. The agger nasi cells are anatomically the most anterior ethmoidal air cells, extending externally towards the frontal ridge and beneath it, and also anteriorly and superiorly to the middle concha junction. In our study, these cells were associated with high rate of maxillary sinusitis. In previous studies, agger nasi cell was shown to be the etiology of sinusitis [5,9,13]. Haller cells are located in the infraorbital area, and are the most anterior ethmoid cells. They are important in that they may block the OMC and thus cause recurrent maxillary sinusitis [26].We found a statistically significant relationship between the Haller cells and maxillary and sphenoid sinusitis. This relationship was reported in some previous studies as well [5,9,13]; however, some others did not report such a correlation [8,10,12]. Onodi cells are the extension of the most posterior ethmoid cells into the sphenoid sinus, and are very close to the optic nerve.

Table 6. Prevalence of sinonasal anatomical variations (%) in previous studies

Study	Year	Septal deviation	Spur formation	Concha bullosa	Paradoxical middle concha	Agger nasi cell	Haller cell	Onodi cell
Present study	2019	95	53	27	15	44	13	29
Bijani et al [8]	2018	73.8	-	29.1	11.7	5.8	5.2	-
Sarkar et al [29]	2016	74.8	-	32.9	6.7	3.5	18	2.6
Shpilberg et al [27]	2015	98.4	32.3	26	15.6	83.3	39.1	12
Khajavi et al [25]	2015	49	12	26	5	-	-	-
Kaygusuz et al [12]	2014	72.3	-	41.5	13.8	64.6	13.8	9.2
Shrikrishna et al [11]	2013	30	-	38	5	6	11	-
Fadda et al [5]	2012	58.5	-	49.3	6.4	24.3	22.8	8.5
Nitinavakarn et al [10]	2005	-	-	50	-	92	23.9	25
Arslan et al [26]	1999	-	-	30	3	-	12	10
Bolger et al [39]	1991	96	-	53.6	27.1	98.5	45.9	11

This anatomical variation was not significantly associated with sinusitis in our study and some previous studies [5, 9, 25, 27]; however, Senturk et al. [28] found opposite results.

In the present study, some hypothesized relationships were not confirmed. The reason for the difference in the reported frequency of normal variations in different studies is that some studies only considered large-size variations. Also, a larger sample size can yield more accurate results. This study assessed the correlation of Task Force on Rhinosinusitis symptoms with the opacification degree observed on CT scans, that may or may not indicate true CRS. The maxillary sinus was the most commonly involved paranasal sinus. This finding was in agreement with the findings of some other studies [24,29]. Table 7 shows the prevalence of sinus opacities in the present and some previous studies.

In our study, a significant correlation was noted between opacification indicative of the presence of sinus involvement on CT scan and symptoms of anterior or posterior purulent (discolored) nasal drainage, nasal obstruction/ blockage, hyposmia/anosmia, halitosis, cough, and fatigue among the symptoms of CRS. One study suggested that use of clinical criteria alone for the diagnosis of CRS would overestimate its prevalence. Moreover, they did not consider pain as a helpful criterion for the diagnosis of CRS [30]. In another study by Kenny et al, [17] there was no correlation between headache and facial pain/pressure with CT findings, but significant correlations were noted between fatigue and sleep disorders with disease severity on CT scans, and also between nasal symptoms and hyposmia and ethmoid sinus involvement. Also, a correlation was noted between the severity of disease on CT scan and the severity of symptoms as in the present study. Pruna [31] also found that patients with more symptoms had a higher opacification degree in the maxillary, anterior ethmoid, and frontal sinuses. In addition, nasal congestion was the most common symptom among patients, but nasal discharge was more strongly associated with the evidence of opacification degree, and there was a high association between opacification degree of the ethmoid sinus and hyposmia, which is consistent with the results of our study regarding the anterior ethmoid sinus involvement.

In another study, the most commonly reported symptoms were nasal discharge, nasal obstruction, fatigue, headache, and dysosmia [32], which were similar to the results of our study. In a study by Abrass et al, [33] most patients with nasal obstruction had positive findings of paranasal sinus involvement on CT scans, but patients with post-nasal drip were less likely to have positive findings on CT scans. In a study by Pokharel et al, [18] the overall symptom score was also significantly correlated with the radiographic score and endoscopic score. In another study, facial pain alone was rarely considered as a symptom of CRS and they did not report a relationship between pain and CT findings.

Table 7. Prevalence of sinus opacities (%) in some studies

Study	Year	Sinus involvement				
		Maxillary	Anterior ethmoid	Posterior ethmoid	Sphenoid	Frontal
Present study	2019	96	87	62	45	42
Sarkar et al [29]	2016	82.5	43.8	43.2	27.7	28.7
Amodu et al [24]	2014	81.7	68.3	68.3	20	40
Ryan et al [37]	2011	72.5	58.8	54.9	43.1	58.8
Lloyd et al [40]	1991	83	63	57	49	60
Bolger et al [39]	1991	77.7	84.3	38.6	25.4	36.6

They found that pain in CRS was the result of association of CRS with some other diseases [34]. However, some other studies found no significant relationship between sinonasal symptoms and CT findings such as opacification degree [35,36]. In studies by Ryan et al, [37] and Hwang et al, [20] the association between CT findings and clinical symptoms was poor; also, nasal discharge and nasal obstruction were found to be moderately correlated with CT findings.

In fact, it should be noted that the variability in patient responses and thresholds in expression of symptoms can also affect the results. In a study by Skoulas et al, [38] the diagnostic value of CT was only slightly higher than that of plain radiography, and no significant correlation was found with symptoms. One reason for the variability in the results could be the lack of calibration of the samples for acute, chronic, and recurrent sinusitis. Basu et al, [35] showed no such a relationship either. In the present study, opacification was found in one or more paranasal sinuses in 100% of the patients, which highlights the importance of CT examination in CRS. This finding was different from the results of Basu et al, [35] who found that CT was not suitable for assessment and scoring of CRS. Very small sample size and the long interval between filling out the questionnaire and obtaining CT scan were the weaknesses of the study by Basu et al, [35] and may be responsible for significant effect of confounding factors such as the upper airway infection on CT findings [35].

In addition, medication intake, age, gender, and smoking status can also affect CRS [33,34]. Finally, controversy in the results of studies can be due to the shared symptoms of different sinonasal diseases.

In this study, only CRS patients were evaluated. In addition to clinical and radiographic findings of CRS, anatomical variations and their effect were also evaluated in this study. One strength of this study was that only a few previous studies have evaluated the paranasal sinuses separately [24,29,37,39,40]. One limitation of this study was difficult localization and differentiation of headache, toothache and earache by patients, that could have affected the results. Further studies with a larger sample size are required to assess sinus involvement in presence of polyps and allergies to provide comprehensive informa-tion regarding the relationship of CT findings and clinical symptoms of CRS.

CONCLUSION

This study revealed that certain types of anatomical variations of the paranasal sinuses (paradoxical middle concha, septal deviation, agger nasi cell, and Haller cell) can increase the susceptibility to sinusitis. CT can help clinicians to predict the severity of symptoms such as purulent (discolored) anterior or posterior nasal discharge, blockage/nasal obstruction, hyposmia/anosmia, halitosis, cough, and fatigue among the symptoms of CRS.

CONFLICT OF INTEREST STATEMENT

None declared.

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