Original Research

CT Analysis of Inflammatory Lesions of Paranasal Sinuses

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ABSTRACT

Background & aim: Computed tomography (CT) is regarded as the "gold standard" in the primary imaging of inflammatory sinonasal lesions. The present study was conducted with the aim to perform a CT analysis of inflammatory lesions of paranasal sinuses. **Material method:** A cross-sectional radiographic study was conducted among randomly selected 156 CT scans that have been collected from patients who are clinically and radiographically diagnosed with paranasal sinus pathologies. However, 58 scans were excluded due to various reasons like presence of trauma, poor quality images etc and so 98 scans were further assessed. **Results:** Paranasal sinus pathologies were found to be most prevalent in the age group of 46-60 years affecting males more than females. The maxillary sinus was the most commonly affected. The most common sinus pathology was reported to be mucormycosis (fungal sinusitis) and the pathologies were found to be present more bilaterally. **Conclusion:** Paranasal sinus pathologies may mimic symptoms of orofacial pain. Thus dentists in general and oral physician in particular should not overlook sinus diseases as the cause of dental and facial pain. Also, a careful and thorough investigation can detect anatomical variations and pathoses that affect the maxillofacial area. Hence, it is imperative for an oral radiologist to have knowledge of the same.

Keywords: Paranasal Sinuses, Inflammatory Lesions, Computed Tomography

The paranasal sinuses are hollow, air-filled spaces located within the bones of the face and the base of the skull surrounding the nasal cavity. There are four pairs of sinuses, each connected to the nasal cavity by a small canal. They include the frontal, ethmoidal, maxillary, and sphenoid sinuses.[1] Paranasal sinuses play a vital role which includes; humidifying and warming of inspired air, controlling pressure within the nasal cavity, reducing the weight of the skull, and helping in the resonance ability of the nasal cavity.[2] Moreover, the shape and structure of the face and paranasal sinuses may act as a crumple zone in severe trauma, protecting the brain.[3] The normal paranasal sinus anatomy displays a wide spectrum of pneumatization and bony variants. The complex anatomy challenges both general and dental radiologists reporting sinonasal disease and ear, nose, and throat (ENT) surgeons performing functional endoscopic sinus surgery (FESS). In 1929, Mosher, an ENT surgeon, wrote: "if it was placed in any other part of the body, it would be an insignificant and harmless collection of bony cells. In the place where nature has put it, it has major relationships so that disease and surgery of the labyrinth often lead to tragedy. Any surgery in this region should be simple but it has proven to be one of the easiest ways to kill a patient." [4]

The spectrum of paranasal sinuses pathologies includes congenital disorders, inflammatory diseases, and tumors; of which inflammatory sinus disease is the most common.[2,5] The clinical assessment of paranasal pathosis is hampered by the surrounding bony structures, hence for confirmation of their diagnosis, the role of radiology is of

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paramount importance.[6] Standard plain radiographs have a limited role in the imaging of the paranasal sinuses and are used as the initial technique before the application of computed tomography (CT). The refinement of CT technology has resolved the traditionally difficult problem of identifying lesions of the paranasal sinuses. The improvement in tissue resolution that CT offers over plain films allows the evaluation of subtle changes in soft tissues, bones, and air-containing spaces. The ability of CT to image the bony details, as well as, soft tissues is the greatest advantage over previous radiographic modalities.[5] Moreover, CT is regarded as the "gold standard" in the primary imaging of inflammatory sinonasal lesions.[4] Thus, the aim of study was to do a CT analysis of inflammatory lesions of paranasal sinuses.

MATERIAL AND METHODS

A cross-sectional radiographic study was conducted among 156 CT scans of patients with paranasal sinus pathologies during the period of Oct 2019 to Jan 2022 with the required demographic data. Siemens 128-slice multidetector helical CT machine was used. The scans were assessed in all three planes i.e., axial, coronal, and sagittal. All the radiographs in which there was the presence of any inflammatory pathology encroaching or arising from the paranasal sinus were included, whereas, the patients whose demographic data was not available, non-established diagnosis, the patients presenting with trauma to face, improper or poor quality images, and the patients with non-inflammatory pathology were excluded. Thus, a total of 58 scans were excluded and 98 scans were further evaluated.

The radiographic criteria used for the detection of various paranasal inflammatory pathology were as follows:

a) **Mucositis:** Mucosal thickening paralleling the bony wall of the sinus. Mucosal thickening of the maxillary sinus is common in asymptomatic patients, therefore the mucosal lining is considered to be normal when less than 2 mm. In the frontal and sphenoid sinuses, the mucosal lining should not be seen at CT in normal healthy persons. The ethmoid sinuses may undergo cyclical changes referred to as the nasal cycle, and therefore mucosal thickening up to 2 mm is considered a normal finding in the ethmoid sinuses. The nasal cycle is not seen in all individuals and becomes less prominent with age.[4,7-9]
b) **Chronic sinusitis:** Presence of air-fluid level, mucosal thickening, and sclerosis of the sinus wall.[10]
c) **Mucormycosis (Fungal sinusitis):** Presenting as hyperdense polypoidal mass with expansion, remodeling, erosion, and thinning of bony walls of the sinus.[5,7]
d) **Polyp:** Seen as focal thickening of sinus mucosa >5 mm. Also, it usually occurs with a thickened mucous membrane lining.[7,11]
e) **Retention pseudocyst:** Appearing as a well-defined, non-corticated, smooth, dome-shaped mass arising from the floor or lateral wall of the sinus. The internal aspect is homogeneous and more radiopaque than the surrounding air of the sinus cavity.[7]
f) **Mucocele:** Presenting as the circular or hydraulic shape of the sinus which is opacified along with expansion and thinning of the bony walls.[7,11]

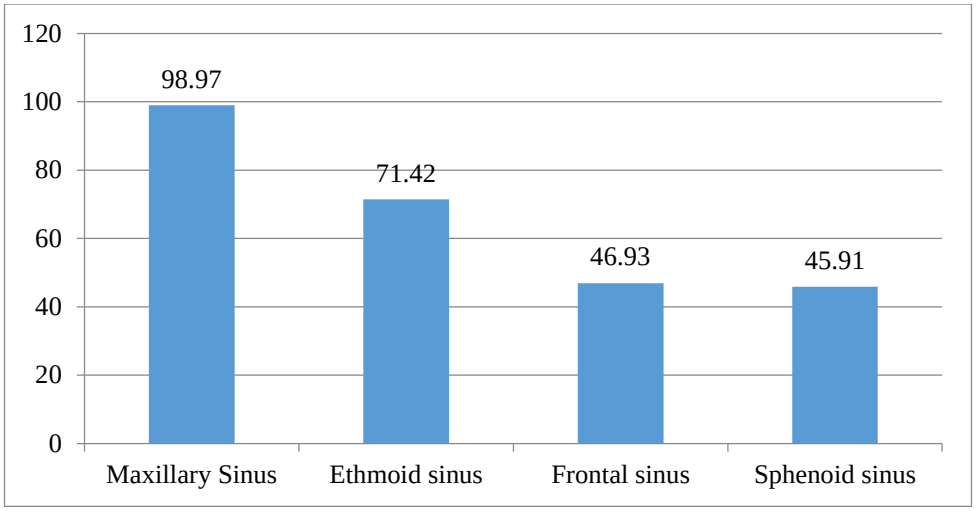
RESULTS

Table 1 shows the distribution of patients with paranasal sinus pathology according to age and gender respectively. The maximum number of patients were in the age group of 46-60 years (36.73%) followed by 31-45 years (29.59%), 61 years and above (22.46%), 16-30 years (9.18%) and 0-15 years (2.04%) respectively. Paranasal sinus pathology was found to be more in males (72.44%) than females (27.56%).

The most common sinus affected was the maxillary sinus (98.97%) followed by ethmoid (71.42%), frontal (46.93%), and sphenoid sinus (45.91%) (Graph.1). Table 2 shows the distribution of patients with paranasal sinus pathology according to the side of involvement in which maximum patients were having bilateral involvement (44.44%) followed by right (28.88%) and left (26.67%) sides respectively. After evaluation of 196 paranasal sinus each (of 98 patients); 160 maxillary, 105 ethmoid, 69 frontal, and 76 sphenoid sinuses showed pathology.

Table 1: Distribution of patients with paranasal sinus pathology according to age and gender

Age Groups	Gender		Pathology Present
	Male	Female	
0-15 years	1 (1.02%)	1 (1.02%)	2 (2.04%)
16-30 years	7 (7.14%)	2 (2.04%)	9 (9.18%)
31-45 years	22 (22.45%)	7 (7.14%)	29 (29.59%)
46-60 years	25 (25.51%)	11 (11.23%)	36 (36.73%)
>60years	16 (16.32%)	6 (6.13%)	22 (22.46%)
Total	71 (72.44%)	27 (27.56%)	98 (100%)



Graph 1: Distribution of paranasal sinus involvement of sinus pathologies (%)

Table 2: Distribution of patients with paranasal sinus pathology according to side of involvement

Type Of Pathology	Maxillary Sinus	Ethmoid Sinus	Frontal Sinus	Sphenoid Sinus
Bilateral	58 (59.79%)	40 (57.14%)	10 (21.73%)	20 (44.44)%
Right side	20 (20.61)%	14 (20%)	19 (41.30%)	13 (28.88%)
Left side	19 (19.6%)	16 (22.86%)	17 (36.90%)	12 (26.67%)
Total	97 (100)%	70 (100%)	46 (100%)	45 (100%)

Table 3: Distribution of prevalence of inflammatory lesions of paranasal sinuses

Type of Pathology	Maxillary Sinus	Ethmoid Sinus	Frontal Sinus	Sphenoid Sinus
Mucormycosis (Fungal inusitis)	97 (60.62%)	78 (74.28%)	53 (76.81%)	51 (67.10%)
Mucositis	34 (21.25%)	8 (7.61%)	4 (5.7%)	11 (14.47%)
Chronic sinusitis	18 (11.25%)	16 (15.23%)	9 (13.04%)	12 (15.78%)
Polyp	7 (4.37%)	3 (2.85%)	3 (4.34%)	2 (2.63%)
Retension pseudocyst	3 (1.87%)	-	-	-
Mucocele	1(0.64%)	-	-	-
Total	160 (100%)	105 (100%)	69 (100%)	76 (100%)

Mucormycosis (fungal sinusitis) was found to be the highest (60.62%) followed by mucositis (21.25%), chronic sinusitis (11.25%), polyp (4.37%), retention pseudocyst (1.87%) and mucocele (0.64%) in the maxillary sinus. In ethmoid sinus, mucormycosis was found to be at its peak (74.28%) followed by chronic sinusitis (15.23%), mucositis (7.61%), and polyp (2.85%). The frontal sinus also showed the prevalence of mucormycosis to be at highest (76.81%) followed by chronic sinusitis (13.04%), mucositis (5.7%), and polyp (4.34%). Moreover in sphenoid sinus also mucormycosis rate was maximum (67.10%) followed by chronic sinusitis (15.78%), mucositis (14.47%), and polyp (2.63%) (Table 3).

DISCUSSION

The development of the paranasal sinus starts during the third and fourth fetal months as evaginations of the nasal mucosa which is closely linked to the development of the facial bones.[2,4] The paranasal sinuses have three essential components; thin normal mucus secretions, normally functioning hair-like cilia that move the mucus out of the sinuses, and open sinus drainage openings (called sinus ostium). Any condition that interferes with the drainage of a sinus renders it liable to infection. Paranasal sinuses lesions are common and affect a wide range of populations with a variety of etiologies. They include a wide spectrum ranging from inflammation to neoplasms.[1] The paranasal sinus pathologies are classified into seven subtypes[7,12-15]: (a) inflammatory disease (mucositis, sinusitis, retention pseudocyst, polyp, antrolith, mucocele, fungus balls, periostitis, and periosteal new bone formation); (b) benign odontogenic cyst; (c) benign odontogenic neoplasms; (d) benign non-odontogenic neoplasm (papilloma, osteoma); (e) malignant neoplasm (squamous cell carcinoma, pseudotumor); (f) bone dysplasia; (g) trauma or iatrogenic

effect (oro-antral communication, fractures of maxillofacial skeleton, foreign bodies within the antrum, dental structures displaced into the sinus). Amongst these, inflammatory conditions are the most frequent sinus pathologies.[16]

The location of chronic sinusitis symptoms, such as facial congestion/fullness, facial pain, headache, and dental pain, may vary from the maxilla and maxillary teeth in maxillary sinusitis to the upper orbit and frontal process in frontal sinusitis, between and behind the eyes in ethmoid sinusitis, and at the junction of the hard and soft palate, occiput, and mastoid process in sphenoid sinusitis. Hence, dentists should be aware of various pathoses of the sinuses.[17] Moreover, CT is considered as a gold standard for sinus lesion diagnosis.[11] Thus, the aim of this study is to establish the role of CT scans in the evaluation of inflammatory pathologies of paranasal sinus and their proper and early diagnosis. In the present study, the maximum number of patients with paranasal sinus pathologies was found to be in the age group of 46-60 years (Table 1). This is consistent with studies done by Sayans MP et al (2020)[16], CC Ani et al (2016)[18] and Bozdemir et al (2015)[17]. Subjects between the ages of 0-15 years were having the least percent of paranasal sinus pathologies which is consistent with the study done by Hussein AO et al (2014) and this could be due to the fact that in children, their ostia are usually very wide and also their sinuses are not fully formed.[1,2,19] However, chronic sinusitis in childhood has been the most frequently suggested explanation of sinus aplasia or hypoplasia. Low O2 saturation and altered temperature secondary to chronic sinusitis or sinonasal polyposis in young children, causing mouth breathing, may contribute to reduced pneumatization.[4]

Paranasal sinus pathologies were found to be more in males than females (Table 1). This is in favor of studies done by Ogolodom MP et al (2018)[2], Drumond JPN et al (2016)[20], and Manjit B (2016)[5]. The increasing number of males being commonly prone to paranasal sinuses pathologies could be attributed to the fact that males are more exposed to dusty and polluted environments especially due to the nature of their occupations such as carpentering and driving.[2] However, according to a study conducted by Hussein AO et al (2014)[1], a higher incidence of paranasal sinus pathologies was found among females than males. Such high incidence among female could be attributed to the fact that; women exposure to dust and smoke from home cleaning and cooking more than men which result in allergic rhinitis which is one factor that causes sinusitis.[1,2] In the current study, pathoses were most commonly seen in the maxillary sinuses (98.97%), followed by the ethmoid (71.42%), frontal (46.93%), and sphenoid sinuses (45.91%) (Graph.1). This is consistent with studies done by Bozdemir E et al (2014)[17] and Hussein AO et al (2014)[1] in which maxillary sinuses have the highest percent of involvement followed by ethmoid sinus and the least was sphenoid sinuses. These findings in this study and other previous studies have been attributed to the anatomical location of the frontal, ethmoidal, and sphenoidal sinuses which are anatomically located above the nasal cavities, therefore, their drainage into the nasal cavity is assisted by gravity; especially when their openings are not obstructed by disease, so that changes or alterations in the aforementioned paranasal sinuses may initially be subtle and not a radiological evident until it becomes extensive with blockage of sinus openings. On the other hand, poor anatomical position drainage predisposes the maxillary sinus to stagnation of secretions and infection more than any other paranasal sinus. [1,2,19]

Paranasal sinus pathologies were predominantly found to be bilateral in the present study (Table 2). This finding is in agreement with the studies done by Sakthivel et al (2021)[21], Graco et al (2012)[22,] and Smith KD et al (2010)[23]. However, according to a study done by Ogolodom MP et al (2018)[2], the right side had the highest percentage of involvement followed by the left side and bilateral sides involvement was the least common. Moreover, in the present study, the most common sinus pathology in all the sinuses was found to be mucormycosis (fungal sinusitis), followed by mucositis, chronic sinusitis, polyp, retention pseudocyst and mucocele in maxillary sinus; chronic sinusitis, mucositis, and polyp in the ethmoid, frontal, and sphenoid sinus (Table 3). This is in favor of a study done by Ogolodom MP et al (2018)[2] in which sinusitis was found to be the highest followed by polyp and mucocele. However, according to Kanwar SS et al (2017)[6], and Verma et al (2016)[24], the most prevalent sinonasal pathology was chronic sinusitis, followed by polyp and fungal pathosis. In this study, the highest incidence of mucormycosis (fungal sinusitis) could be attributed due to the POST COVID MUCOR outbreak in various states of India during the year 2021.The limitations of this study are its relatively small size and data regarding the occupation and habits of the subjects were not accessible which may be a cause for sinus changes in males and females. Also, data about histological confirmation was not available.

CONCLUSION

Paranasal sinus pathologies may mimic symptoms of orofacial pain. Thus, dentists in general and oral physician in particular should not overlook sinus diseases as the cause of dental and facial pain. Also, a careful and

thorough investigation can detect pathoses that affect the maxillofacial area. A wide spectrum of diseases affecting the sinonasal cavities can be detected by CT with high accuracy. Thus, CT plays an indispensable role in the detection and characterization of paranasal sinus pathologies by adding important findings for better management of patients with paranasal sinus disease. Hence, it is imperative for an oral radiologist to have sound knowledge of the same.

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