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ORIGINAL ARTICLE

Anatomic Variation of Paranasal Sinuses

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Abstract:

Introduction: The sinus are very important on the upper respiratory tract, formed by the ostrich complex (COM) and by the paranasal sinuses. The deep knowledge of the anatomy and variations of the ostium-meatal complex and the paranasal sinuses is a skill expected from the radiologist as well the possible variations with the disease states. **Objective:** The aim of this study was to evaluate the prevalence of anatomic variations and pathological processes in the paranasal sinuses and the ostiomeatal complex in a population of a large city. Furthermore, association among the presence and localization of anatomic variations and the occurrence of pathological processes was also accessed. **Materials and Methods:** This study evaluated 1005 CT scans of the sinuses obtained by multislice technique (64 apparatus detectors) with axial and coronal reconstructions, both with 1 and 2 mm thick. Patients of both sexes, aged between 12 and 92 years, who were referred by otolaryngologists were included. **Results:** Our results showed high prevalence of paranasal sinus CT alterations. The most common were: septal deviation (80.7%), concha bullosa (35.1%), Haller cells (9.6%), and ethmoidal bulla (3.3%). Among the pathological processes, mucoperiosteal thickening associated with acute and chronic inflammation of the sinuses were the most frequent. Ocasionally, it caused obstruction of drainage ostiomeatal complex, in addition to sinusitis (acute and chronic). Odontogenic sinusitis, fungal sinusitis, osteomas, fibrous dysplasia and nasal diseases were also found. There was no association among anatomical variations (changes in the nasal septum, bone spur, concha bullosa, nasal turbinate hypertrophy) and increased chances of obstruction of drainage of frontal, ethmoid and maxillary sinuses. **Conclusion:** Association between obstruction of the drainage and the occurrence of sinusitis on all paranasal sinuses were also detected. As the population has a high frequency of anatomical variations of the paranasal sinuses, the incorrect interpretation of the images of the sinonasal complex should cause misdiagnosis, compromising patient care. In conclusion, knowledge of the prevalence and characteristics of paranasal sinus CT alterations should be useful for defining specific diagnosis criteria.

Keywords: Cone-Beam Computed Tomography; Paranasal Sinuses; Radiology Department, Hospital; Otorhinolaryngologic Diseases.

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INTRODUCTION

The sinus are very important component on the upper respiratory tract, formed by the ostrich complex (COM) and by the paranasal sinuses[1]. The infections with inflammation (acute and chronic sinusitis), traumas (oral sinusial communication, fractures of the maxillofacial skeleton and the presence of foreign bodies inside the sinonasal cavities, mainly in the maxillary sinuses), presence of cysts and other bone diseases (fibrous dysplasia, osteopetrosis) can affect the paranasal sinuses directly or indirect way[2].

The inflammatory sinus disease has been considering the crônica disease A Sinus disease is considering a cronic disease with the higher prevalence in all age groups and the fifth largest cause of antibiotic use[3]. The, respiratory infections and allergies are the main predisposing factors of sinus disease, since they initiate alterations in the lining mucosa of the paranasal sinuses, which may predispose to sinusitis[1,3].

The anatomy evaluation of paranasal sinuses and all the variation possible are very important, so they can allow identify some pathogenesis, which can have someinfluencing on the treatment[1]. The image study on the bucomaxillofacial region, specially the sinonasal, it is fundamental to help the diagnostic of this respiratory diseases. The anatomy knowledge and all the possible variation are relevant to conclude this precise diagnosis[4]. Besides all that, the image exam it is what will be showing us the differentiation between the various diseases of the sinus region and in determining the extent of the disease[5].

Mostly paranasais diseases are rhinogenic originated and they are disseminated by the COM, compromising the frontal sinus and the maxillaries on second place. The COM anatomy are composed of slits (they are located on the lateral nasal wall), and are easily narrowed or obstructed by mucosal edema, resulting as a bad ventilation, mucociliary cleaning failure and retention of mucus with purulent contents in the paranasal sinuses, mainly the frontal and maxillary sinuses.

When we have anatomy variation on this region, the slits will be narrowed, with the formation of mucosal edema predisposing the patient to a recurrent infection, which may result in chronic inflammatory changes in the mucosa. However, the process is reversible, if the COM drainage pathways have been redone, the secondary disease treats spontaneously[1].

The computed tomography (CT) has a very important meaning on the refractory acute cases with the clinical therapy on the situations that has a complications suspected and in chronic or recurrent cases, especially in those who have surgical indication, and in the postoperative evaluations, being an image examination of high sensitivity. With the CT we can identify indicatives sines of sinus disease such as: opacification, moderate to severe thickness of the paranasal sinus lining mucosa and hydro-aerial level in patients with persistent clinical symptoms[6].

The deep knowledge of the anatomy and variations of the ostium-meatal complex and the paranasal sinuses is a skill expected from the radiologist as well the possible variations with the disease states[7].

As the Brazilian population has a high frequency of anatomical variations of the paranasal sinuses, the incorrect interpretation of the images of the sinonasal complex should cause misdiagnosis, compromising patient care. In conclusion, knowledge of the prevalence and characteristics of paranasal sinus CT alterations should be useful for defining specific diagnosis criteria.

The aim of this study was to evaluate the prevalence of anatomic variations and pathological processes in the paranasal sinuses and the ostiomeatal complex in a population of a large city using CT as a imaging exam required for otorhinolaryngological evaluation.

MATERIALS AND METHODS

This study was approved by the ethics comittee number 0120.0.213.000-09.

This study evaluated 1005 CT scans of the sinuses obtained by multislice technique (64 apparatus detectors) with axial and coronal reconstructions, both with 1 and 2 mm thick. Patients of both sexes, aged between 12 and 92 years, who were referred by otolaryngologists were included.

The exams were required by the otolaryngologist in a private clinic in Belo Horizonte, Brazil, between January and April 2010 in patients with indication of imaging for the diagnosis of anatomical alterations or pathological processes in the sinonasal region. The exams were taking using a CT Multislice - Somatom Sensation (Simens) with 64 slices, with an average of 80mAs and 100 kVp, and exposure time between 5 and 8 seconds to acquire the exams as recommended the manufacturer.

To evaluate the prevalence of pathological processes according to the patients age, the exams were divided into 4 groups according to the following age groups: Range A (age between 12 and 18 years); Range B (age between 19 and 40 years); C range (age between 41 to 65 years) and D range (age over 65 years).

RESULTS

A percentage of 97.3 of the exams showed at least one type of tomographic alteration (anatomical variation or pathological process) of the sinonasal region, with the remaining ones (2.7%) within the normal range.

Table 1 shows the number of patients exhibiting anatomical variations. The results showed that the septum's deviation was the most commonly detected anatomical variation (80.7% of the exams), and 33.4% the septum's deviation showed associated bone spurs. In 353 cases (35.1%) bullous shells were found, being 17.2% unilateral and 17.9% bilateral. Ethmoidal blister was found in 33 patients (3.3%), and in 99.9% of the COM obstruction's cases was observed. The Haller cells, which were visible in 96 cases (9.6%), 48.9% of these also showed COM's obstruction with drainage pathways.

The other anatomical variations were found: 140 cases (14%) with turbinate hypertrophy, 32 cases (3.2%) with frontal sinus hypoplasia, 10 cases (1%) with frontal sinus agenesis, and Galli crest, maxillary sinus hypoplasia and Agger nasi cells, representing less than 1% occurrence in the sample. Variations involving the uncinate process, exuberant maxillo-ethmoid cells, sphenoidal sinus pneumatization, bone sclerosis of the sinus walls and septa within the maxillary sinus were occasionally detected.

Table 1. Anatomical variations in the nasal region and paranasal sinuses detected in multislice computed tomography scans analyzed.

Anatomical variations	Characteristics	Frequence
Winding nasal septum	total	123 (12,2%)
Deviation of nasal septum	total	689 (68,5)
	with bone spurs	230 (22,9%)
Bullous shells	total	353 (35,1%)
	unilateral	173 (17,2%)
	bilateral	180 (17,9%)
Ethmoidal bull	total	33 (3,3%)
	with drainage path obstruction	30 (3%)
Haller's Cell	total	96 (9,6%)
	with drainage path obstruction	47 (4,7%)
Hypertrophy of inferior turbinates	total	140 (14%)
Pneumatization of the Galli crest	total	2 (0,2%)
Hypoplasia of maxillary sinus	total	5 (0,5%)
Agenesis of the frontal sinus	total	10 (1%)
Frontal sinus hypoplasia	total	32 (3,2%)
Aggner Nasi	total	3 (0,3%)

On each age group alone, no predominant pathological process was observed. The frequencies of mucoperiosteal thickening in the frontal, ethmoidal, sphenoid and maxillary sinuses were 29.3%, 39.7%, 31.2% and 70%, respectively, and in 64.7% of cases of mucoperiosteal thickening exhibited drainage in the frontal sinus, 53.1% in the ethmoidal sinus, 55.4% in the sphenoid sinus and 43.6% in the maxillary sinus.

On Table 2, the results of sinusopathies occurrence showed that 21.5% of the cases presented frontal sinusopathy, 28.1% etmoidal, 21.9% sphenoidal and 42.9% maxillary, with 75.6% of the maxillary sinusopathies, were bilateral. The majority of cases of sinusopathy were chronic in all sinuses evaluated. About the acute sinusopathies, the maxillary sinus was the most affected. In the sample studied, we found polypoid formations (25.6%), pansinusopathy (12.5%), odontogenic sinusopathy (1%), fungal sinusopathy (0.4%), rhinosinusopathy (4.3%), rhinopathy (1.8%), nasal polyp (6.5%) and osteomas (1.9%) with predominance in the frontal sinus.

The results showed that, when there is no mucoperiosteal thickening, anatomical variations alone cause obstruction of the drainage pathways in only a small cases percentage.

On the Table 3, the results showed that most exams present sinusopathies also showed drainage pathways obstruction: 82.3% in the frontal sinus, 72% in the ethmoidal sinus, 76.5% in the sphenoid sinus and 61% in the maxillary sinus. The associations's analysis showed presence of an association between drainage pathways obstruction and sinusopathy's presence.

On the examinations evaluation with pansinusopathy (involvement of three or more sinuses, which may be unilateral or bilateral), there were high frequencies of obstruction on the frontal (83.8%), ethmoidal (85.4%) or Maxillary (85.4%). It was evaluated whether the pansinusopathies were associated with obstruction on the frontal, ethmoidal or maxillary sinus drainage pathways using the Odds Ratio test (Table 3). The results showed a strong association between sinusopathy and frontal sinus obstruction, ethmoidal and maxillary sinus drainage pathway (Table 3). In addition, there was also a

Table 2. Pathological processes in the paranasal sinuses and ostiomeatal complex detected in multislice computed tomography.

Pathologic Process	Frequence				
	Range A (n=67)	Range B (n=392)	Range C (n=406)	Range D	Total (n=1005)
Frontal Sinus					
Mucoperiosteum thickening	15	107	120	53	295 (29.3%)
Mucoperiosteus thickening with obstruction of drainage pathway	9	69	85	28	191 (19%)
Acute sinusopathy	4	3	7	1	15 (1.5%)
Chronic Sinusopathy	9	71	84	36	200 (20%)
Total Sinusopathy					215 (21.5%)
Ethmoid sinus					
Mucoperiosteum thickening	29	151	154	65	399 (39.7)
Mucoperiosteus thickening with obstruction of drainage pathway	16	78	87	31	212 (21.1%)
Acute sinusopathy	3	8	7	1	19 (1.9%)
Chronic Sinusopathy	18	96	104	45	263 (26.2%)
Total Sinusopathy					282 (28.1%)
Sphenoid sinus					
Mucoperiosteum thickening	28	113	130	43	314 (31.2%)
Mucoperiosteus thickening with obstruction of drainage pathway	15	59	75	25	174 (17.3%)
Acute sinusopathy	2	10	10	1	23 (2.3%)
Chronic Sinusopathy	17	68	83	29	197 (19.6%)
Total Sinusopathy					220 (21.9%)
Maxillary sinus					
Mucoperiosteum thickening	51	271	281	101	704 (70%)
Mucoperiosteus thickening with obstruction of drainage pathway	23	125	120	39	307 (30.5%)
Acute sinusopathy	5	17	20	3	45 (4.5%)
Chronic Sinusopathy	28	144	153	61	386 (38.4%)
Total Sinusopathy					431 (42.9%)
Sinusopathy bilateral	25	122	134	45	326 (32.3%)
Polypoid formation in the sinus	24	107	98	28	257 (25.6%)
Pan sinusopathy	8	43	52	23	126 (12.5%)
Odontogenic sinusopathy	0	1	6	3	10 (1%)
Fungal sinusopathy	0	2	1	1	4 (0.4%)
Rhinosinusopath	3	25	10	5	43 (4.3%)
Rhinopathy	1	10	0	7	18 (1.8%)
Nasal polyp	2	24	26	13	65 (6.5%)
Osteoma	0	2	12	5	19 (1.9%)

strong association between pansinusopathy and drainage pathways obstruction of these sinuses.

Our results showed high prevalence of paranasal sinus CT alterations. The most common were: septal deviation (80.7%), concha bullosa (35.1%), Haller cells (9.6%), and ethmoidal bulla (3.3%). Among the pathological processes, mucoperiosteal thickening associated with acute and chronic inflammation of the sinuses were the most frequent. Ocasionally, it caused obstruction of drainage ostiomeatal complex, in addition to sinusitis (acute and chronic). Odontogenic sinusitis, fungal sinusitis, osteomas, fibrous dysplasia and nasal diseases were also found.

There was no association among anatomical variations (changes in the nasal septum, bone spur, concha bullosa, nasal turbinate hypertrophy) and increased chances of obstruction of drainage of frontal, ethmoid and maxillary sinuses. Association between obstruction of the drainage and the occurrence of sinusitis on all paranasal sinuses were also detected.

Table 3. Associations between sinusopathies and obstruction of drainage on the frontal, ethmoidal, sphenoidal and maxillary sinuses.

Anatomical variation / pathological process	Drainage path obstruction	N	p value	OR
Frontal Sinus				
Sinusopathy	Yes	177	<0.05	258.18
Sinusopathy	No	38		
Ethmoidal sinus				
Sinusopathy	Yes	203	<0.05	203.85
Sinusopathy	No	79		
Sphenoidal sinus				
Sinusopathy	Yes	169	<0.05	506.35
Sinusopathy	No	52		
Maxillary sinus				
Sinusopathy	Yes	263	<0.05	18.85
Sinusopathy	No	168		
Frontal Sinus				
Pansinusopathy	Yes	109	<0.05	20.61
Pansinusopathy	No	21		
Ethmoidal sinus				
Pansinusopathy	Yes	111	<0.05	18.85
Pansinusopathy	No	19		
Maxillary sinus				
Pansinusopathy	Yes	111	<0.05	15.02
Pansinusopathy	No	19		

As the population has a high frequency of anatomical variations of the paranasal sinuses, the incorrect interpretation of the images of the sinonasal complex should cause misdiagnosis, compromising patient care. In conclusion, knowledge of the prevalence and characteristics of paranasal sinus CT alterations should be useful for defining specific diagnosis criteria.

DISCUSSION

On the study, a percentage of 97.3 of the exams showed at least one type of tomographic alteration (anatomical variation or pathological process) of the sinonasal region. Dutra and Marchiori[3] reported in their studies that 22.5% of the patients were considered normal, they did not present any alteration at the lining mucosa of the paranasal sinuses or in the COM region. On this study, 2.7% patients presented a normality aspect in their examinations, which is a lot less than the study before. This high prevalence of tomographic alterations is justified by the fact that all the exams have been requested by otorhinolaryngologists with clinical suspicion of some pathological alteration in the sinonasal region. In addition, several works in the literature cite high frequencies of anatomical variations in this region[8-10].

The particularity of this study was the case series evaluated, 1005 multislice computed tomography exams, which is much higher than other studies in the literature[4,10-12].

Regarding the lesions or diseases associated with the paranasal sinuses, it was observed that the thickening of the paranasal sinus mucosa was the tomographic alteration most prevalent in this study, being present in the frontal sinus in 29.3% of cases, ethmoidal in 39.7 %, sphenoidal at 31.2% and maxillary at 70% of cases. Similar results were observed by other authors[4].

The most frequent paranasal sinuses disease found in this study was sinusopathy agreeing with the findings of Okuyemi and Tsue[13].

CONCLUSIONS

As the paranasal sinuses area are both, doctors and dentists, study object, the obtaining, interpreting and issuing reports of images of the bucomaxillofacial region and attached structures can be performed by medical and dental radiologists. The dental surgeon degree provides the dental radiologist a solid knowledge about the anatomy, anatomical changes and lesions on the maxillofacial complex, as well as procedures related to implantology, stomatology and buccomaxillofacial surgery.

This way, greater interaction between medical and dental radiology professionals can contribute to a better interpretation of paranasal sinuses images, helping to define their meaning, establishing limits of normality patterns, and more specific criteria for diagnostic conclusion.

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