ROLE OF ANATOMICAL VARIATIONS IN CHRONIC NON POLIPOID RHINOSINUSITIS

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ABSTRACT

Introduction*: Chronic rhinosi-nusitis (CRS) is a significant health problem. The osteomeatal complex (OMC) obstruction represents a key factor in the development of this pathology. We report our experience on the evaluation of the presence of anatomical variations of the OMC and nasal septum in patients with and without CRS. We analyzed also the impact of these variations, alone or in combination, on the onset of CRS.*

Methods*: This is a retrospective study. Patients affected by chronic rhinosinusitis (CRS group) submitted to volumetric computed tomography (VCT) of the nose and paranasal sinuses before they underwent functional endoscopic sinus surgery were recruited. Patients without disease of the nose or paranasal sinuses submitted to VCT for other indications were considered as control group (N-CRS group).*

Results*: 138 patients were included in this study, 78 were included in the CRS group and 60 in the N-CRS group. Concha bullosa was detected in 71.8% and 53.4% of the CRS group and N-CRS group, respectively; P=0.03. Analyzing the contextual presence of more than one anatomical variation, we found that 70 (89.8%) of the 78 patients with CRS exhibited more than one concomitant ipsilateral variation, while 42 (70%) of the 60 N-CRS subjects had more than one concomitant ipsilateral variation, and this difference was statistically significant (P=0.004). In our study, we observed a correspondence between the site of the multiple variations and the site of paranasal sinuses involved in the CRS group.(P=0.045)*

Conclusions*: Anatomic variations could facilitate the onset or persistence of CRS.*

Keywords: *Chronic rhinosinusitis, paranasal sinuses, osteomeatal complex, nasal and paranasal anatomical variations.*

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Introduction

Chronic rhinosinusitis (CRS) is defined as an inflammatory process that affects the nasal mucosa and paranasal sinuses and persists for more than 12 consecutive weeks[(1)]. Nasal obstruction, nasal secretion (anterior and/or posterior), headache, facial pain, and changes in the sense of smell are the diagnostic symptoms that must be confirmed by the objective presence of inflammation using nasal endoscopy or computed tomography of the paranasal sinuses. CRS is divided into two main phenotypic groups: CRS with nasal polyps and CRS without nasal polyps. CRS is a significant public health problem and affects 5-12% of the general population[(2)]. This pathology has a negative impact on the patient's quality of life; hence, it must be correctly identified and treated. The genesis of rhinosinusitis is multifactorial; physiological (mucociliary clearance) and mechanical obstructive factors are equally important[(3)]. The osteomeatal complex (OMC) represents the common drainage pathway of the frontal sinus, maxillary sinus, and anterior ethmoid sinus. Obstruction at this level represents a key factor in the development of CRS. The presence of concha bullosa (pneumatization of the middle turbinate),

Haller cells (extending from the anterior ethmoid inferiorly towards the middle-basal wall of the orbit), or pneumatized agger nasi cells are the obstructing factors of the OMC, and therefore, facilitate the onset of rhinosinusitis[4]. Volumetric computed tomography (VCT) of the paranasal sinuses exhibits good sensitivity and specificity for the diagnosis of CRS. Along with the medical history and clinical findings, VCT increases the accuracy of diagnosing CRS. VCT plays a central role in the diagnosis of CRS owning to its ability to demonstrate the obstructive pathology, delineate mucosal conditions, and visualize the distal structures that cannot be viewed with direct endoscopy, such as the posterior ethmoid sinus, or fragile structures, such as the papyrus lamina of the ethmoid[5].

Therefore, VCT images allow the detection of all anatomical anomalies possibly related to CRS. Numerous studies in the literature have tried to establish the impact of each individual anatomical variation on the onset of CRS. However, the results are often discordant. Herein, we report our experience on the evaluation of the presence of anatomical variations of the OMC and nasal septum in patients with and without CRS. We also analyzed the impact of these variations, alone or in combination, on the onset of CRS.

Patients and methods

This retrospective study was performed at the Radiology Unit of the University of Catanzaro on patients with a previous diagnosis of non polypoid CRS during the period January 2018 and December 2019 and candidate to functional endoscopic sinus surgery. The selected patients were submitted to VCT of the nose and paranasal sinuses before they underwent functional endoscopic sinus surgery (CRS group). The exclusion criteria of the study were as follows: patients <18 years of age, patients previously treated surgically for pathologies related to the nose and sinuses, those affected by massive polypoid rhinosinusitis, allergy and patients with craniofacial tumors or malformations. The control group consisted of participants without symptoms of rhinosinusitis who underwent VCT in the same period for other indications (craniofacial pain), and showed no signs of CRS on VCT (N-CRS group). This retrospective study was conducted on archived data, and according to our institution review board, this study did not require any ethical approval. All patients provided written informed consent.

Volumetric computed tomography

VCT was performed using a 64-row multislice CT scanner (Toshiba Aquilion CX 64-slice CT scanner, Tokyo- Japan). Scanning was performed with a direct axial slice thickness of 1 mm. A high-resolution algorithm was used to enhance the fine bony details of the OMC. VCT scans were evaluated by two expert radiologists with more than 20 years of experience (US and CA) and one otolaryngologist (MRB). Coronal slices were considered mainly; however, axial and sagittal projections were also taken into account for the most accurate evaluation of some structures, such as the agger nasi and ethmoid bulla. The data were collected for the right nasal fossa and left nasal fossa and stored in special databases. The pattern and severity of the inflammatory changes in the paranasal sinuses were graded using the Lund-Mackay scoring system[6]. This scale uses a scoring scale ranging between 0 and 2. According to the Lund-Mackay scoring system, for the sinuses: 0 = no abnormalities; 1 = partial opacification; and 2 = total opacification. Furthermore, for the OMC (scored only with a scale of 0 or 2), 0 = not occluded, 2 = occluded. The left and right sides were scored separately. The maximum score was 24 considering all the sinuses, with a higher score corresponding to a more serious pathological condition.

Statistical analysis

Statistical analysis was performed using the MedCalc software (version 9.0; MedCalc Software bvba, Ghent, Belgium). The Fisher's exact test was used to identify differences in anatomical alteration data between cohorts. A P-value of < 0.05 was considered statistically significant. Data collected included the mean and standard deviation.

Results

A total of 138 participants were selected and included in this study, of whom 90 were women (65.3%) and 48 were men (34.7%), with a mean age of 50.01 ± 15.80 years (range 18-91 years). In the 138 patients, septal deviation was the most common anatomic variant, affecting 102/138 patients (73.9%).Another frequent anatomical variant was concha bullosa, which affected 88/138 patients (63.77%). A pneumatized ethmoid bulla was present in 44/138 (31.8%) patients. Anatomical variations of the uncinate process were present in 83/138 (60.1%) patients (Table 1).

Anatomical variations	Right, N(%)	Left , N(%)	Bilateral, N(%)	Total, N(%),
Septal deviation	50 (49.0)	52 (51)		102 (73.9%)
Pneumatized ethmoid bulla	14 (31.8)	20 (45.4)	10 (22.8)	44 (31.8%)
Pneumatized agger nasi cell	4 (28.5)	1 (7.1)	9 (64.2)	14 (10.1%)
Middle turbinate -Concha bullosa -Paradoxical -Total of variations	18 (20.4) 4 (33.3) 22 (22)	20 (22.8) 4 (33.3) 24 (24)	50 (56.8) 4 (33.3) 54 (54)	88 (63.8) 12 (8.6) 100 (72.5)
Uncinate process -Lateral deviation -Medial deviation -Pneumatization -Total of variations	8 (28.5) 12 (35.3) 10 (47.6) 30 (36.1)	4 (14.3) 10 (29.4) 7 (33.3) 21 (25.4)	16 (57.2) 12 (35.3) 4 (19.1) 32 (38.5)	28 (33.7) 34 (41) 21 (25.3) 83 (60.1)
Haller cell	7 (19.5)	6 (16.7)	23 (63.8)	36 (26.1)

Table 1: Anatomical variations from volumetric computed tomography scans of 138 patients.

Of these 138 patients, according to clinical-anamnestic data and VCT evaluation, 78 (56.6%) were affected by CRS (CRS group), while 60/138 (43.4%) patients were considered not affected by CRS (N-CRS group).

CRS group

Of the 78 patients in the CRS group, 48 (61.5%) were women and 30 (38.5%) were men. The mean age was 51.15 ± 14.93 years (range 24-77 years). Anatomical variations were found in 76/78 (97.4%) patients. The most common anatomical variations in these patients were alterations of the middle turbinate in 63/78 (80.8%) patients, followed by deviation of the nasal septum in 62/78 (79.5%) patients, and anatomical variations of the uncinate process in 50/78 patients (64.1%). Pneumatized ethmoid bulla was observed in 26/78 patients (33.3%). (Table 2). Six of the 78 (7.7%) patients had only one anatomical variation: 4/6 (66.7%) on the left side and 2/6 (33.3%) on the right side. Of the 78 patients, 70 (89.8%) patients had more than one concomitant anatomical variation: 10/70 (14.3%) on the right side, 6/70 (8.5%) on the left side, and 54/70 (77.2%) bilaterally.

According to the VCT evaluation, the paranasal sinuses, alone or in association, were involved as follows: the maxillary sinus in 70 of the 78 (89.8%) patients, of these 20/70 (28.6%) on the right side, 8/70 (11.4%) on the left side, and 42/70 (60%) bilaterally. The frontal sinus was involved in 24/78 (30.8%) patients, of these 8/24 (33.3%) on the right side, 8/24 (33.3%) on the left side, and 8/24 (33.3%) bilaterally. The anterior ethmoid sinus was involved in 12/78 (15.4%) patients, of these 1/12 on the right (8.3%) side, 1/12 on the left (8.3%) side, and 10/12 (83.4) bilaterally.

Anatomical variations	Right, N(%)	Left , N(%)	Bilateral, N(%)	Total, N(%),
Septal deviations	30 (48.3)	32 (51.7)		62 (79.5)
Pneumatized ethmoid bulla	12 (46.2)	10 (38.4)	4 (15.4)	26 (33.3)
Pneumatized agger nasi cell	4 (50)	1 (12.5)	3 (37.5)	8 (10.2)
Middle turbinate -Concha bullosa -Paradoxical -Total of variations	14 (125) 2 (28.5) 16 (25.4)	12 (21.4) 3 (43) 15 (23.8)	30 (53.6) 2 (28.5) 32(50.8)	56 (71.8) 7 (8.9) 63 (80.8)
Uncinate process -Lateral deviation -Medial deviation -Pneumatization -Total of variations	6 (33.3) 7 (35) 6 (50) 19 (38)	2 (11.1) 6 (30) 4 (33.3) 12 (24)	10 (55.6) 7 (35) 2 (16.7) 19 (38)	18 (23.1) 20 (25.6) 12 (15.4) 50 (64.1)
Haller cell	5 (22.8)	4 (18.1)	13 (59.1)	22 (28.2)

Table 2: Anatomical variations from computed tomography scans of 78 patients with chronic rhinosinusitis.

The posterior ethmoid sinus was involved in 8/78 (10.2%) patients, of these 2/8 (25%) on the right side, 2/8 (25%) on the left side, and 4/8 (50%) bilaterally. The sphenoid sinus was involved bilaterally in 12/78 (15.4%) patients. Obstructed OMC was present in 28/78 patients (35.9%), of these 5/28 (17.8%) on the right side, 10/28 (35.8%) on the left side, and 13/28 (46.4%) bilaterally. A correlation was observed between the site of multiple anatomical variations and paranasal sinuses involved. Sixteen of the 70 (22.9%) patients had multiple unilateral anatomical variations, and 10 of these (62.5%) had ipsilateral rhinosinusitis. Fifty-four of the 70 patients (77.2%) had multiple bilateral anatomical variations. Of these, 36/54 (66.6%) patients had bilateral sinus involvement, while 18/54 (33.4%) had unilateral sinus involvement (P = 0.045) (Table 3). The mean paranasal sinus involvement score obtained through the Lund-Mackay staging was 5.1 ± 3.30 (range 1-14).

	Sinusitis	
Multiple variations (N°of patients)	Bilateral N°(%)	Monolateral N°(%)
Bilateral 54	36 (66.7%)	18 (33.4%)
Monolateral 16	6 (37.5%)	10 (62.5%)
	P=0.045	

Table 3: Correspondence between site of multiple variations and paranasal sinuses involved.

N-CRS group

Of the 60 patients in the N-CRS group, 18 (30%) were men and 42 (70%) were women, and the mean age was 48.86 ±17.01 years (range 18-91 years). Anatomical variations were found in 54/60 (90%) of the patients. The most common anatomical variation was nasal septal deviation observed in 40/60 (66.6%) patients. Thirty-seven of the 60 patients (61.7%) presented anatomical variations in the middle turbinate, 33 of 60 (55%) showed varia-

tions in the uncinate process, and 18 (30%) of the 60 patients presented with pneumatized ethmoid bulla. (Table 4). Forty-two of the 60 (70%) patients had more than one concomitant anatomical variation, 12/42 (28.5%) on the left side and 2/42 (4.8%) on the right side, while 28/42 (66.7%) presented bilateral anatomical variations. Twelve of the 60 (20%) patients had only one anatomical variation: 7/12 (58.4%) on the right side, 5/12 (41.6%) on the left side. Only 6/60 (10%) of the patients did not show any anatomical variations.

Anatomical Variations	Right, N(%)	Left, N(%)	Bilateral, N(%)	Total, N(%),
Septal deviations	20 (50)	20 (50)		40 (66.6)
Pneumatized ethmoid bulla	2 (11.1)	10 (55.5)	6 (33.4)	18 (30)
Pneumatized agger nasi cell	_	_	6 (100)	6 (10)
Middle turbinate -Concha bullosa -Paradoxical -Total of variations	4 (12.5) 2 (40) 6 (16.2)	8 (25) 1 (20) 9 (24.3)	20 (62.5) 2 (40) 22 (59.5)	32 (53.4) 5 (8.4) 37 (61.7)
Uncinate process -Lateral deviation -Medial deviation -Pneumatization -Total of variations	2 (20) 5 (35.7) 4 (44.4) 11 (33.3)	2 (20) 4 (28.5) 3 (33.3) 9 (24.3)	6 (60) 5 (35.8) 2 (22.3) 13 (39.4)	10 (16.6) 14 (23.4) 9 (15), 33 (55%)
Haller cell	2 (14.3)	2 (14.3)	10 (71.4)	14 (23.4)

Table 4: Anatomical variations from volumetric computed tomography scans of 60 patients without chronic rhinosinusitis.

Correlation of anatomical variations in the CRS and N-CRS groups

The most frequent anatomical variation observed in patients with CRS was that of the middle turbinate (80.8%), while in case of patients in the N-CRS group, deviation of the nasal septum was the most frequent (66.6%) presentation. On comparison of the data the percentage of anatomical variations of the middle turbinate was higher in the CRS group than that in the N-CRS group (80.0% vs. 61.7%, respectively; P = 0.02), with a statistically significant difference. Concha bullosa was detected in 71.8% and 53.4% of the patients in the CRS and N-CRS groups, respectively (P = 0.03) (Table 5).

Deviation of the nasal septum, pneumatized ethmoid bulla, and anatomical variations of the uncinate process were more evident in the CRS group than in the N-CRS group, although this difference was not statistically significant. Pneumatized agger nasi and Haller's cells were found in a similar percentage between the two study groups. On analyzing the contextual presence of more than one anatomical variation of the OMC and nasal septum, we found that 70 (89.8%) of the 78 patients in the CRS group exhibited more than one concomitant ipsilateral anatomical variation, while 42 (70%) of the 60 patients in the N-CRS group had more than one concomitant ipsilateral anatomical variation with a statistically significant difference (P = 0.004) (Table 5 and Figure 1). Furthermore, a higher percentage of a single anatomical variation related to the nasal cavity (mono and bilateral) in the N-CRS group than that in the CRS group was noted (20% vs 7.6%, respectively; P = 0.04) (Figure 2).

Anatomical variations	CRS n.78 N. (%)	N-CRS n.60 N. (%)	P value
Nasal septum	62 (79.5)	40 (66.6)	0.11
Middle turbinate	63 (80.8)	37 (61.7)	0.02
Ethmoid bulla	26 (33.3)	18 (30)	0.71
Uncinate process	50 (64.1)	33 (55)	0.29
Agger nasi	8 (10.2)	6 (10)	1.00
Haller cell	22 (28.2)	14 (23.4)	0.56
> 1 ipsilateral anatomical variation	70 (89.8)	42 (70)	0.004

Table 5: Correlation between anatomical variations found in the CRS and N-CRS groups.

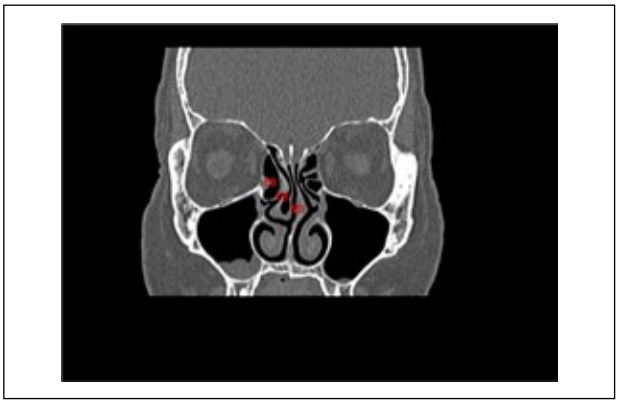

Fig. 1: Volumetric computed tomography coronal section. *EB: pneumatized ethmoid bulla; CB: concha bullosa; SD: septal deviation*

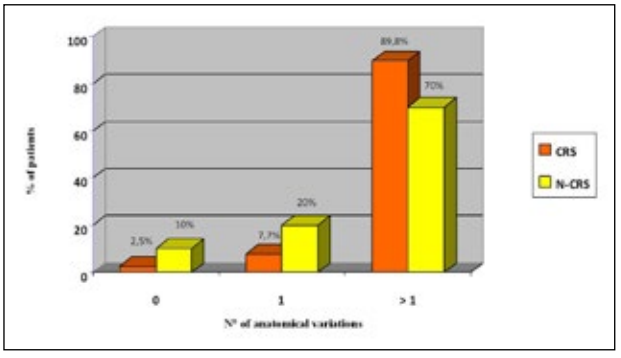

Fig. 2: Number of anatomical variations present in the two groups of patients: 0 = no variations; 1 = only one variation per nasal cavity; and > 1 variation per nasal cavity.

Discussion

The role of anatomical variation in OMC obstruction remains controversial. Many studies have evaluated the impact of anatomical variations of the nasal cavities on the onset of CRS[5,7-12]. However, until today, only a few studies have compared the anatomical variations found in patients with CRS

with respect to those in patients without CRS. Some authors claim that anatomical variations do not affect the onset of CRS; however, other authors have presented data that show a statistically significant correlation between the presence of some anatomical variations and CRS. The anatomical variations that were most frequently encountered in the CRS group were those of the middle turbinate (80.8%), while in the N-CRS group, the most frequently encountered anatomical variations were that of the nasal septum (66.6%).

In agreement with our results, Roman et al.[13] and Azila et al.,[14] reported a correlation between anatomical variations of the middle turbinate and CRS. In addition, Clark et al.[15] had found concha bullosa in 33% of cases with symptoms of sinusitis, and in 11% of cases in the control group ($P < 0.001$). On the contrary, other authors[15,16] did not find any correlation between anatomical variations and CRS. Kayqusuz et al.[16] observed that the anatomical variations most frequently found were those affecting the nasal septum (72.3% in the CRS and 73.5% in the N-CRS group) and the agger nasi cell (64.6% in the CRS group and 55.8% in the control group). Cappelli et al.[17] found the presence of concha bullosa in 41.1% of patients with CRS, 44.5% of patients without CRS patients, and Haller cells in 45.5% of patients with CRS and in 33.4% of N-CRS patients. Bolger et al.[18] found no statistical difference in the incidence of concha bullosa between patients undergoing scanning for sinus or non-sinus complaints. In our study, the presence of multiple anatomical variations correlated with CRS (89.8% and 70% for CRS and N-CRS groups, respectively), while in the N-CRS group, a single anatomical variation was present. A previous study by Aramani et al.,[19] which considered only patients with CRS, reported the prevalence of multiple anatomical variations (53.7%) with respect to a single anatomical variation (33.3%). Tes et al.[20] analyzed the relevance of the association of deviated nasal septum and concha bullosa; however, they did not find any correlation with CRS. The obstructive potential of each single anatomical variation is added to that of the others present simultaneously; thus, multiplying their action as an obstacle to the physiological draining function of the OMC.

In our study, we observed a correspondence between the site of multiple anatomical variations and paranasal sinuses involved in the CRS group. Of the 54 patients with CRS who had multiple anatomical variations bilaterally, 66.6% had bilateral sinus involvement, while of the 16 patients who had unilateral multiple anatomical variations, 62.5% had ipsilateral sinus involvement ($P = 0.045$). This result highlights that the multiple anatomical variations, which are mostly present in the patients with CRS, can have an impact on the onset or maintenance of sinus pathology. To the best of our knowledge, no other studies have evaluated the presence of multiple anatomical variations in patients with and without CRS and found a correlation between multiple anatomical variations and ipsilateral sinusitis. However, this study has some limitations represented by the small number of patients present in the two groups compared. Furthermore, the correlation between anatomical variations and a single paranasal sinus affected by inflammatory processes was not taken into consideration.

Conclusions

In conclusion, anatomical variations of the OMC and nasal septum were found in both the CRS and N-CRS groups. We identified a greater number of patients with multiple anatomical variations in the CRS group than in the N-CRS group. Multiple concomitant anatomical variations could facilitate the onset or persistence of CRS.

However, CRS is a multifactorial pathogenetic disease; therefore, other predisposing factors, such as allergies, cigarette smoking, genetic diseases, dysbiosis, and other factors, should always be considered.

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