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Paranasal Sinuses Anatomic Variants and its Association with Chronic Rhinosinusitis

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Abstract

Objective: To determine the prevalence of sinonasal anatomic variants and to assess their association with sinonasal mucosal disease and its impact in the Lund-Mackay score.

Materials and Methods: 112 consecutive sinus CT scans were evaluated for the presence of anatomic variants of the sinonasal cavities and the presence of sinonasal disease. The Lund-Mackay score was calculated in all cases.

Results and Discussion: The CT scans of the paranasal sinuses of 112 individuals were reviewed and compared. The comparison included 33 individuals with chronic rhinosinusitis and 79 individuals without chronic rhino sinusitis. The following anatomical variations were found: 24 (72.7%) septal deviations in the rhinosinusitis group and 59 (74.7 %) in the healthy group, 28 (84.8%) Agger nasi in the rhinosinusitis group and 70 (88.6%) in the healthy group, 8 (24.2%) Onodi cell in the rhinosinusitis group and 23 (29.1%) in the healthy group, 13 (39.4%) Haller's cells in the rhinosinusitis group and 32 (29.1%) in healthy group. None of these results were significantly different between the rhinosinusitis group and the healthy group ($p>0.05$). The Lund-Mackay score was calculated for each anatomic variant and no significant correlation was observed ($p>0.05$).

Conclusion: The results showed no statistically significant association between the sinonasal anatomical variations and the pathologies of the paranasal sinus.

Keywords:

Anatomical variations; Chronic rhinosinusitis; Computed tomography; Paranasal sinus; Lund-Mackay score

Introduction

The increasing interest in endoscopic sinus surgery has put the anatomy of the paranasal sinus on the spotlight. Research about the relation between anatomic variants and their possible consequences on nasal permeability and on rhinosinusitis has been growing in recent years.

Several authors have studied the relationship between sinonasal anatomic variants and the incidence of rhinosinusitis, but this is still a matter of discussion. It is argued by some that certain anatomic variations in the nose can possibly contribute to the blockage of the drainage and ventilation of the ostiomeatal units, therefore increasing the risk of sinus mucosal disease [1,2].

At the same time, knowledge of the precise nasal anatomic variants is key in the preoperative evaluation of patients undergoing sinus surgery. The complexity of the nose and the paranasal sinuses anatomy as well as its variants may create

technical difficulties during surgery. As certain anatomic variants are considered as risk factors for sinus surgery, the study of the patient anatomy may contribute to improved surgical outcomes.

Objective

To determine the prevalence of sinonasal anatomic variants and to assess their association with sinonasal mucosal disease and its impact in the Lund-Mackay score.

Material and Methods

A cross-sectional observational study was conducted at a tertiary healthcare institution - Hospital Pedro Hispano, Matosinhos, Portugal between October and December 2017. Patients who were observed by an otorhinolaryngologist and underwent sinus CT scan were included. The exclusion criteria included patients having acute rhinosinusitis, fungal rhinosinusitis or nasal neoplasms; being younger than 18 years old; having previous nasal surgery. Those who were not followed-up by an otorhinolaryngology were also excluded from the study.

A sinonasal checklist was made (Attachment 1) where epidemiological data about the patient, pathologic signs and Lund Mackay score were recorded. Anatomic variants of the septum, turbinates, unciform process, maxillary sinus, frontal sinus and recess, ethmoidal and sphenoid sinus were identified. The depth of the olfactory fossa was valued using the Keros classification.

The participants selected for the study were subjected to detailed history taking and clinical examination and were sub-divided into two groups: Those with chronic rhinosinusitis and those without. The classification criteria used was based on the European Position Paper on Rhinosinusitis and nasal Polyps [3] Sinus CT scans were done in both coronal, axial and sagittal planes.

The CT scans were examined by a senior certified neuroradiologist. The presence of anatomical variations was documented along with any radiological features of chronic rhinosinusitis, together with the radiological Lund Mackay (LM) score.

The prevalence of anatomic variations of the paranasal sinuses and nasal cavity was calculated for each group. Correlations between the presence of anatomical variants and the chronic rhinosinusitis were determined using the following statistical tests when appropriate: Independent samples T-Test, one-way ANOVA and Pearson's Chi-Square, (SPSS v22 software). Statistical significance was assumed at a p-value under 0.05.

Results

In total, 112 subjects were enrolled in the study, 33 with chronic rhinosinusitis and 79 without it. The subjects' age interval ranged from 19 to 76 years (mean: 46.5 years). 48 (42.9%) were men and 64 (57.1%) women (Table 1).

Table 1: The age of male and female subjects between rhinosinusitis group and control group.

Variables	Rhinosinusitis group	Control group
Male	15 (45.4%)	33 (41.8%)
Female	18 (54.5%)	46 (58.2%)

The most common anatomic variation found on the CT scans was the Agger nasi cell, which was present in 98 (87.5%) subjects, 28 (84.8%) on the rhinosinusitis group and 70 (88.6%) on the control group. The second most common variation was the nasal septum deviation (which was defined as>2mm) present in 87 subjects (77.7%), 24 (72.7%) on the rhinosinusitis group and 59 (74.7%) on the control group.

Sphenoethmoidal cell (Onodi cell) [4] was present in 33 (29.5 %) subjects, 8 (24.2%) on the rhinosinusitis group and 23 (29.1%) on the control group.

Infraorbital cell (Haller cell) (4) was present in 36 (32.1%) subjects, 13 (39.4%) on the rhinosinusitis group and 23 (29.1%) on the control group.

The middle turbinate insertion is also revised in a sinus CT evaluation. It extends upward to insert into the lateral wall in most of the cases; it can also be inserted on the skull base or the middle turbinate [5]. On our sample, 139 (62.1%) were inserted on the lateral wall, 48 (21.4%) on the middle turbinate, 36 (16.1%) on the skull base, and 1 (0.4%) lied free without upper insertion (Tables 2-26).

Table 2: Anatomical variations between rhinosinusitis group and control group.

Variables	Rhinosinusitis group	Control group
Lateral wall	50(75.8%)	89(56.3%)
Middle turbinate	9(13.6%)	39(24.7%)
Skull base	7(10.6%)	29(18.4%)
Lying free	0(0%)	1(0.6%)

We measured the impact of each variant on the ipsilateral Lund Mackay score to understand if there was any variation that could be related with rhinosinusitis development.

Table 3: Chronic rhinosinusitis: Septum deviation-right side.

Variables		Chronic rhinosinusitis		Total
		Yes	No	
Septum deviation (Right side)	Yes	14(42.4%)	28(35.4%)	42
	No	19(57.6%)	51 (64.6%)	70
Total		33 (100%)	79 (100%)	112(100%)

Table 4: Pearson's Chi-Square test.

Variables	Exact Sig.
Pearson's Chi-Square	0.484

Table 5: Nasal septum deviation: Right side.

Variables		n	Lund Mackay score (average)
Nasal septum deviation (Right side)	Yes	42	2.26 Standard Error=0.47
	No	70	1.70 Standard Error=0.34

Table 6: T-Test.

Variables	Sig.
Independent samples T-test (Equal variances assumed,2-tailed)	0.323

Table 7: Chronic rhinosinusitis: Septum deviation-Left side.

Variables	Chronic rhinosinusitis			Total
		Yes	No	
Septum deviation (Left side)	Yes	13(39.4%)	32(40.5%)	45
	No	20(60.6%)	47(59.5%)	67
Total		33 (100%)	79(100%)	112(100%)

Table 8: Pearson's Chi-Square.

Variables	Exact Sig.
Pearson's Chi-Square	0.913

Table 9: Nasal septum deviation: Left side.

Variables		n	Lund Mackay score (average)
Nasal septum deviation (Left side)	Yes	45	1.56 Standard Error=0.37
	No	67	1.76 Standard Error=0.35

Table 10: T-Test.

Variables	Sig.
Independent samples T-test (Equal variances assumed, 2-tailed)	0.206

Table 11: Agger Nasi: Right side.

Variables		n	Lund Mackay score (average)
Agger nasi (Right side)	Yes	101	1,82; Standard Error=0.28
	No	11	2,73; Standard Error=1.02

Table 12: T-Test.

Variables	Sig.
T-Test (Equal variances assumed, 2-tailed)	0.328

Table 13: Agger Nasi: Left side.

Variables		N	Lund Mackay score (average)
Agger nasi (Left side)	Yes	96	1,67 Standard Error=0.28
	No	16	1,75 Standard Error=0.61

Table 14: T-Test.

Variables	Sig.
T-Test (Equal variances assumed, 2-tailed)	0.909

Table 15: Haller cell: Right side.

Variables		n	Lund Mackay score (average)
Haller cell (Right side)	Yes	37	2,27 Standard Error=0.45
	No	75	1,73 Standard Error=0.34

Table 16: T-Test.

Variables	Sig.
T-Test (Equal variances assumed, 2-tailed)	0.359

Table 17: Haller cell: Left side.

Variables		n	Lund Mackay score (average)
Haller cell (Left side)	Yes	35	2.23 Standard Error=0.50
	No	77	1.43 Standard Error=0.29

Table 18: T-Test.

Variables	Sig.
t-test for quality of means	0.143

Table 19: Onodi Cell: Right side.

Variables		n	Lund Mackay score (average)
Onodi cell (Right side)	Yes	20	4,40 Standard Error=0.53
	No	91	3,31 Standard Error=1.46

A unique case of agenesia was not included in this analysis.

Table 20: T-Test.

Variables	Sig.
T-Test (Equal variances assumed, 2-tailed)	0.411

Table 21: Onodi Cell: Left Side.

Variables		N	Lund Mackay score (average)
Onodi cell (Left side)	Yes	22	2.45 Standard Error=0.59
	No	90	3.80 Standard Error=0.88

Table 22: T-Test.

Variables	Sig.
T-Test (Equal variances assumed, 2-tailed)	0.292

Table 23: Middle turbinate insertion: Right side.

Variables		n	Lund Mackay score (average)
Unciform Process (Right side)	Lateral wall	74	2.22 Standard Error=0.36
	Middle Turbinate	17	1.24 Standard Error=0.62
	Skull base	20	1.40 Standard Error=0.54
	Lying free	1	1.00

Table 24: ANOVA test.

Variables		Sum of squares	dF	Sig
ANOVA	Between groups	20.708	3	0.487

Table 25: Middle Turbinate insertion: Left side.

Variables		n	Lund Mackay score (average)
Unciform Process (Left side)	Lateral wall	66	2.08 Standard Error=0.365
	Middle Turbinate	30	1.20 Standard Error=0.344
	Skull base	16	0.94 Standard Error=0.622

Table 26: ANOVA test.

Variables		Sum of squares	dF	Sig
ANOVA	Between groups	26.070	2	0.162

Discussion

The importance of the anatomic variations of the paranasal sinus as predisposing patients to chronic rhinosinusitis is debatable [6,7]. In this regard, many studies failed to show a specific association between the anatomic variants of paranasal sinuses and chronic rhinosinusitis. Kim et al. and Stallman et al. claimed that local, systemic, environmental factors or intrinsic mucosal disease were more significant factors in the pathogenesis of rhinosinusitis [8,9]. In our study those variables could not be accessed, due limited access to these data.

In our study, the most common anatomic variant was the Agger nasi cell, which was present in 87.5% of the sample. This value is similar to the results found in the literature (70-90%) [4,9]; there were differences in mean LM score between subjects with and without the Agger Nasi, particularly on the right side; however, this difference was not statistically significant. Previous studies did not find an association between frontal sinus disease and Agger nasi cells [10].

The second most common variant was the nasal septum deviation, which was present in 77.7 % of the subjects, a value concordant within the previously reported range of 19.4%–79% [1,8,11,12]. We have not found any statistical significant association between the nasal septum deviation and the prevalence of rhinosinusitis or even with an increase in the Lund Mackay score. Similarly, other studies did not show an association between septal deviation and chronic rhinosinusitis [8,11,12].

Sphenoethmoidal cell (Onodi cells) is defined as a posterior ethmoidal cell which develops lateral and/or superiorly to the sphenoid sinus [4]. It was present in 33 (29.5%) patients, 8 (24,2 %) on the rhinosinusitis group and 23 (29,1 %) on the control group. The differences between the Lund Mackay score in the two groups was not statistical significant. On previous studies, the reported prevalence is between 1,3%-65% [8,11,13].

Infraorbital cell (Haller cell) is an anterior or posterior ethmoidal cell that develops into the orbital floor, where it may narrow the adjacent maxillary sinus ostium or infundibulum. It may be defined as any ethmoidal cell which pneumatizes inferior to the orbital floor and lateral to a line parallel with the lamina papyracea [14]. In our sample, it was present in 36 (32,1 %) of patients, 13 (39,4%) on the rhinosinusitis group and 23 (29,1%) on the control group. These values were within the 10%-62% reported range [8,11,15]. The difference between the Lund-Mackay score in both groups was not statistically significant.

The middle turbinate insertion was also investigated. A higher percentage of subjects had a lateral wall insertion on the rhinosinusitis group (75.8 % *vs.* 56.3 %). Concurrently, the Lund-Mackay score seems to be increased on these patients, but this difference was not statistically significant when compared to other insertions. The prevalence in our sample matches previous reports [5].

As described above, we did not find a statistically significant difference in the Lund-Mackay score of the paranasal sinus or the nasal cavity anatomic variants. However, we did not study the association between groups of variations and the presence of rhinosinusitis, which can be a limitation of this study. At the same time, the small sample size may have limited the results of this study. Moreover, we did not distinguished chronic rhinosinusitis patients with or without nasal poylps. We recognize these are different entities, with different etiology and pathogeny, however, the small sample size limited this analysis. Further studies with larger samples may be important to better understand the impact of sinonasal anatomic variants on the rhinosinusitis pathogenesis and the difference between Chronic Rhinosinusitis with and without Nasal Polyps.

Despite evaluating the presence or absence of the anatomical variations, we did not assess the size and severity, which limits our results. It is known that in some cases, patients can have symptoms related with the anatomic variants without rhinosinusitis expression on CT scan [15]. Therefore, the anatomic knowledge of the paranasal sinuses is of great importance. At the same time, it is known that patients with clinically significant sinusitis may have no evidence of sinusitis at imaging [16]. That is the reason why is so important to evaluate clinically these cases and not blindly agree on the CT scan.

This anatomic knowledge is key on the pre-surgical evaluation, since some variants are related with an increase in the complication rates of sinus surgery. Although surgical complications may occur for a variety of reasons, failure to recognize certain anatomic variants is one of the most important. In fact, the communication between the surgeon and the radiologist is crucial.

Conclusion

The Sinus CT scan is a major tool for evaluating chronic rhinosinusitis, helping to assess the mucosal disease on the sinus and to study the extent of the disease. However, it should not be the only tool used in these patients. The clinical evaluation is essential and the CT should complement it. There are a multitude of anatomic variations on sinus anatomy, and many argue about the impact of these variations on the physiopathology of chronic rhinosinusitis.

Despite all the limitations of this study, our results agree with the majority of the literature, suggesting that there is a limited impact of the anatomic variants on the physiopathology of chronic rhinosinusitis. For this reason, the CT scan of the paranasal sinus for the study of the sinus anatomy maybe be avoided unless surgery is indicated. For these patients, the knowledge of the anatomic variants may help prevent some complications.

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