Tomographical Findings in Adult Patients Undergoing Endoscopic Sinus Surgery Revision

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Abstract

Introduction Many patients undergoing functional endoscopic sinus surgery still have an uncontrolled clinical disease in the late post-operative period. Up to 11.4% of the patients will require a revision surgery. Findings such as the residual uncinated process and the lateralization of the middle turbinate were considered by some studies as being responsible for failure in the primary surgery.

Objectives To describe the tomographical findings in adult patients undergoing revision endoscopic sinus surgery, the profile of those patients, and verify the mucosal thickening level of the paranasal sinus.

Methods Data were collected from medical records and computed tomography reports of 28 patients undergoing revision sinus surgery on a private service in the city of Blumenau between 2007 and 2014. The score of Lund-Mackay was used to verify the mucosal thickening level.

Results Among the 28 patients, 23 were reoperated once, 3 were reoperated twice, and 2 were reoperated 3 times. The most relevant findings were mucosal thickening of the maxillary sinus (89.28%), deviated septum (75%), thickening of the ethmoid (50%) and sphenoidal sinuses (39.28%), and pneumatization of the middle turbinate (39.28%). The average obtained in the Lund-Mackay score was 5.71, with most patients classified in the lower range of punctuation.

Conclusion The analysis of the computed tomography scans showed persistent structures that may be responsible for the failure of the primary surgery. Computed tomography is a useful tool to plan the surgery and quantify the post-operative success.

Keywords
- sinusitis
- otorhinolaryngologic surgical procedures
- reoperation

Introduction

Chronic rhinosinusitis (CRS) is a common condition in the population. There are not practical statistics about this disease in Brazil, but in the US it is believed that ~ 14% of adults are affected by CRS.[1] Most patients have good results with clinical treatment combining antibiotics, decongestants, mucolytics and steroids.[2] Functional endoscopic sinus surgery (FESS) has been established as one of the main methods in the treatment of CRS refractory to medical therapy, and has been considered the preferred procedure for these cases.[1,3]

With the popularity of this technique among otolaryngologists, FESS has been increasingly performed.[4,5] The advance of technology in recent years enabled many improvements in otorhinolaryngology surgery. Despite the increasingly

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sophisticated image techniques and the improvements in endoscopic surgery, there is still a significant number of failures in the postoperative period of FESS. A recent study found that 42.1% of patients undergoing FESS still had an uncontrolled clinical disease in the late post-operative period.[6]

In cases in which symptoms of the disease remain after the performance of FESS, the first choice should be clinical treatment with antibiotics and steroids. If there is continuity of the symptoms, computed tomography (CT) is indicated in an attempt to locate the source of the infection. When an anatomic abnormality responsible for the failure of the primary surgery is found, revision endoscopic sinus surgery (RESS) may be indicated.[7] The rate of patients undergoing FESS who require reoperation is significant, and studies indicate rates such as 11.4% and 7.9% according to the researched location.[6,8]

The CT is an extremely important aspect when dealing with FESS. Besides helping plan the surgery, with the CT, physicians are able to identify and quantify the success of the results in the post-operative period.[9] The Lund-Mackay score (LMS) is a widely used method for staging CSR by CT analysis. It is the most accepted method for research purposes, and it is the first choice for staging chronic sinusitis using a CT scan.[1,9,10] The most frequent tomographical findings after FESS found by Khalil et al (2011) were residual cells in the frontal recess and in the posterior/anterior ethmoid, and obstruction of the sphenoid ostial and residual uncinate processes. The presence of these anatomical structures may suggest the reason behind the persistence or recurrence of rhinosinusitis.[11]

The objectives of this study were to describe the tomographical findings and the profile of adult patients undergoing RESS, and to verify the level of mucosal thickening in the paranasal sinuses.

Method

This retrospective study analyzed patients treated in a private clinic in the city of Blumenau, in the state of Santa Catarina, Brazil. The medical records and the preoperative CT scans of the paranasal sinuses and the nasal cavity of patients undergoing RESS were analyzed. The patients studied were reoperated between January 2007 and December 2014. Adult patients that were symptomatic after FESS and who had to be submitted to RESS were included in the study. Patients without all necessary data in their medical records, patients without a CT scan analyzed by a radiologist, and patients younger than 20 years old on the date that the CT was performed were excluded.

Data collection happened between December 2014 and February 2015. After the first analysis, 33 patients were selected. Five patients were removed from the study, two because they did not have the CT scan attached to the medical record, two because they could not be found to agree to their participation, and one who refused to participate. Thus, this study population was of 28 patients. All of them agreed with their participation in this study and signed the informed consent form.

The tomographical findings and the data necessary to calculate the LMS were verified in the reports of the CT scans. The CT scans and their reports were not done in the same clinic or analyzed by the same radiologist. Therefore, before the inclusion of the tomographical findings as results of this study, the CT scan images were reviewed by an otorhinolaryngologist. All patients in this study were submitted to a CT of the paranasal sinuses and nasal cavity as a preoperative examination before the RESS. None of the patients was previously submitted to FESS in the same service in which the RESS was performed.

The following information related to the profile of the patients were collected: gender; age; number of reoperations; and interval between surgeries. The CT findings were classified according to the anatomical region or structure where they belong, which are: the nasal septum; the inferior turbinate; the middle nasal turbinate; the superior turbinate; the osteomeatal complex; the uncinate process; the maxillary sinus; the ethmoid sinus; the sphenoid sinus; and the frontal sinus.

To verify the thickening level of the mucosa from the paranasal sinuses, the LMS was used. This tool analyzed the following anatomical structures: the frontal sinus; the maxillary sinus; the sphenoid sinus; the anterior portion of the ethmoidal sinus; 5) the posterior portion of the ethmoid sinus; and the osteomeatal complex. Both sides of these structures receive grades ranging from 0 to 2. The score was 0 when no abnormalities were found, 1 when a partial opacification was found, and 2 if total opacification was found. The exception is the osteomeatal complex, which only received the grade 0 when it was not occluded, and 2 when it was occluded. The grades were based on the appearance of each structure on the CT of the paranasal sinuses. Finally, the score of each side and the total of the patient were calculated.

Data were collected, listed, organized and analyzed using the software Microsoft Office Excel 2013 (Redmond, Washington, US). This same software was also used to calculate the standard deviation (SD), the mean and the median. This study was approved by the Ethics Committee Universidade Regional de Blumenau (under number 879 433, approved on November 20, 2014).

Results

Among the 28 patients analyzed, 11 (39.29%) were female, and 17 (60.71%) were male. The average age was 37.32 years, and the median was 36.5 years (SD: 10.24). The lower and higher ages were 20 and 61 years old respectively. It was also found that 23 patients (82.14%) were reoperated once, 3 patients (10.72%) were reoperated twice, and 2 patients (7.14%) required reoperation 3 times. The mean number of reoperations was 1.25 (SD: 0.58). The interval between operations was not possible to determine in four patients because of the absence of accurate information in their medical records. The interval between the primary surgery and the reoperation was observed in 24 patients. It presented a variation from 1 to 17 years, with a mean of 5.66 years (SD: 4.68). The interval between the first and second reoperations

was observed in 3 patients, and it ranged from 1 to 5 years, with a mean of 3.33 years (SD: 2.08). It was possible to check the interval between the second and third reoperations in only one patient, and it was two years. All of the data on the profile and the sinonasal surgical history can be seen in ►**Table 1**.

The findings of the preoperative CT scans were separated according to the related anatomical structure, as shown in ►**Table 2**. In the nasal septum area, 21 patients (75%) with deviated septum, 3 patients (10.71%) with septal perforation, and 1 patient (3.57%) with mucosal thickening along the nasal septum were identified. No abnormalities were found in 6 patients (21.42%). In the inferior nasal turbinate area, 2 patients (7.14%) with obliteration of the inferior meatus, 1 patient (3.57%) with a partial reduction of the volume, and 1 patient (3.57%) with signs of total resection were identified. No abnormalities were found in 24 patients (85.71%). In the middle nasal turbinate area, 11 patients (39.28%) with signs of pneumatization, 3 patients (10.71%) with signs of partial resection, 3 patients (10.71%) with middle nasal turbinate lateralization, and 2 patients (7.14%) with mucosal thickening were identified. No abnormalities were found in 11 patients (39.28%). In the osteomeatal complex, 5 patients (17.35%) with obliteration of the middle meatus, 1 patient (3.57%) with signs of resection, 1 patient (3.57%) without osteomeatal units, and 1 patient (3, 57%) with polyps related to the osteomeatal units were identified. No signs of manipulation were found in 21 patients (75%). In the uncinated process area, 2 patients (7.14%) with signs of resection and 26 patients (92.85%) with the usual morphology and insertion were identified.

In the maxillary sinus area, 25 patients (89.28%) with mucosal thickening, 3 patients (10.71%) with calcification inside the sinus, 2 patients (7.14%) with residual Haller cells, 1 patient (3, 57%) with signs of previous sinus surgery, and 1 patient (3.57%) with resection of the anterior walls were identified. No abnormalities were found in 3 patients (10.71%). In the ethmoidal sinus area, 14 patients (50%) with mucosal thickening, 1 patient (3.57%) with residual ethmoidal cells, and 1 patient (3.57%) with a retention cyst were identified. No abnormalities were found in 13 patients (46.42%). In the sphenoid sinus area, 11 patients (39.28%) with mucosal thickening, 4 patients (14.28%) with obliteration of the sphenoethmoidal recess, 1 patient (3.57%) with obliteration of the sphenoethmoidal cells (Onodi cells), 1 patient (3.57%) with enlargement of the drainage pathways, and 1 patient (3.57%) with signs of periosteitis were identified. No abnormalities were found in 17 patients (60.71%). In the frontal sinus area, 8 patients (28.57%) with mucosal thickening, 7 patients (25%) with obliteration of the frontal recesses, 2 patients (7.14%) with complete obliteration, 1 patient (3, 57%) with osteoma, 1 patient (3.57%) with non-developed sinus, and 1 patient (3.57%) with signs of pneumatization of the interfrontal sinus were identified. No signs of manipulation were found in 18 patients (64.28%).

The LMS results can be seen in ►**Tables 3** and **4**. The general mean in the 28 patients studied was of 5.7143 (SD: 4.6096), ranging between 1 and 19 points. The right side scores had a mean of 2.8571 (SD: 2.2886), varying from 0 to 9. And the left side had a mean of 2.8571 (SD: 2.3838), varying from 1 to 10. The score of the maxillary sinus on the right side had a mean of 0.8214 (SD: 0.4755), varied between 0 and 2, and 21.43% of patients scored 0, 75% scored 1, and 3.57% scored 2. The score of the maxillary sinus on the left side had a mean of 0.8928 (SD: 0.3149), varied between 0 and 1, and 10.71% of the patients scored 0, and 89.29% scored 1. The score of the anterior ethmoid sinus on the right side had a mean of 0.5357 (SD: 0.6372), varied between 0 and 2, and 53.57% of patients scored 0, 39.29% scored 1, and 7.14% scored 2. The score of the anterior ethmoid on the left side had a mean of 0.5357 (SD: 0.6929), varied between 0 and 2, and 57.14% of patients scored 0, 32.14% scored 1, and 10.71% scored 2.

Table 1 Information about the profile and sinonasal surgical history ($n = 28$)

	N	%	Mean	Variation	Standard Deviation
Gender					
Male	17	60.71			
Female	11	39.29			
Age (years)			37.32	20 - 61	10.24
Number of reoperations			1.25	1 - 3	0.58
One reoperation	23	82.14			
Two reoperations	3	10.72			
Three reoperations	2	7.14			
Interval between operations (years)*					
Primary surgery/1st reoperation	24		5.66	1 - 17	4.68
1st reoperation/2nd reoperation	3		3.33	1 - 5	2.08
2nd reoperation/3th reoperation	1		2		

Note: * For the time interval between operations, $n = 24$.

Table 2 Preoperative CT findings in patients undergoing RESS ($n = 28$)

Anatomical structure	Tomographical findings	N	%
Nasal septum	Deviated septum	21	75
	Septal perforation	3	10.71
	Mucosal thickening along the nasal septum	1	3.57
	No abnormalities or signs of previous manipulation	6	21.42
Inferior nasal turbinate	Obliteration of the inferior meatus	2	7.14
	Partial volume reduction	1	3.57
	Signs of resection	1	3.57
	No abnormalities or signs of previous manipulation	24	85.71
Middle nasal turbinate	Signs of pneumatization	11	39.28
	Signs of resection	3	10.71
	Lateralization	3	10.71
	Mucosal thickening	2	7.14
	No abnormalities or signs of previous manipulation	11	39.28
Osteomeatal complex	Obliteration of the middle meatus	5	17.85
	Signs of resection	1	3.57
	Absence of osteomeatal units	1	3.57
	Polyps related to osteomeatal units	1	3.57
	No abnormalities or signs of previous manipulation	21	75
Uncinate process	Residual	2	7.14
	Usual morphology and insertion	26	92.85
Maxillary sinus	Mucosal thickening	25	89.28
	Calcification inside the sinus	3	10.71
	Residual Haller cells	2	7.14
	Resection of the anterior walls	1	3.57
	Signs of previous sinus surgery	1	3.57
	No abnormalities or signs of previous manipulation	3	10.71
Ethmoidal sinus	Mucosal thickening	14	50
	Residual ethmoidal cells	1	3.57
	Retention cyst	1	3.57
	No abnormalities or signs of previous manipulation	13	46.42
Sphenoidal sinus	Mucosal thickening	11	39.28
	Obliteration of the sphenoethmoidal recess	4	14.28
	Obliteration of sphenoethmoidal cells (Onodi cells)	1	3.57
	Enlargement of the drainage pathways	1	3.57
	Signs of periostitis	1	3.57
	No abnormalities or signs of previous manipulation	17	60.71
Frontal sinus	Mucosal thickening	8	28.57
	Obliteration of the frontal recesses	7	25
	Complete obliteration	2	7.14
	Non-developed sinus	1	3.57
	Osteoma	1	3.57
	Pneumatization of the interfrontal sinus	1	3.57
	No abnormalities or signs of previous manipulation	18	64.28

Abbreviations: CT, computed tomography; RESS, revision endoscopic sinus surgery.

Table 3 Collective results of the LMS ($n = 28$)

	Side	Mean	Variation	0 (%)	1 (%)	2 (%)	Standard deviation
Maxillary sinus	Right	0.8214	0 – 2	21.43	75	3.57	0.4755
	Left	0.8928	0 – 1	10.71	89.29	0	0.3149
Anterior ethmoid	Right	0.5357	0 – 2	53.57	39.29	7.14	0.6372
	Left	0.5357	0 – 2	57.14	32.14	10.71	0.6929
Posterior ethmoid	Right	0.5357	0 – 2	57.14	32.14	10.71	0.6929
	Left	0.4827	0 – 2	60.71	28.57	10.71	0.6876
Sphenoidal sinus	Right	0.3214	0 – 1	67.86	32.14	0	0.4755
	Left	0.3214	0 – 1	67.86	32.14	0	0.4745
Frontal sinus	Right	0.3571	0 – 2	67.86	28.57	3.57	0.5587
	Left	0.3928	0 – 2	67.86	25	7.14	0.6288
Osteomeatal complex	Right	0.2857	0 and 2	85.71	-	14.29	0.7127
	Left	0.2142	0 and 2	89.29	-	10.71	0.6299
Total by side	Right	2.8571	0 – 9				2.2886
	Left	2.8571	1 – 10				2.3838
Total		5.7143	1 – 19				4.6096

Abbreviation: LMS, Lund-Mackay score.

The score of the posterior ethmoid on the right side had a mean of 0.5357 (SD: 0.6929), varied between 0 and 2, and 57.14% of patients scored 0, 32.14% scored 1, and 10.71% scored 2. The score of the posterior ethmoid on the left side had a mean of 0.4827 (SD: 0.6876), varied between 0 and 2, and 60.71% of patients scored 0, 28.57% scored 1, and 10.71% scored 2. The score of the sphenoid sinus on the right side had a mean of 0.3214 (SD: 0.4755), varied between 0 and 1, and 67.86% of patients scored 0, and 32.14% scored 1. The score of the sphenoid sinus on the left side had a mean of 0.3214 (SD: 0.4745), varied between 0 and 1, and 67.86% of patients scored 0, and 32.14% scored 1. The score of the frontal sinus on the right side had a mean of 0.3571 (SD: 0.5587), varied between 0 and 2, and 67.86% of patients scored 0, 28.57% scored 1, and 3.57% scored 2. The score of the frontal sinus on the left side had a mean of 0.3928 (SD: 0.6288), varied between 0 and 2, and 67.86% of patients scored 0, 25% scored 1, and 7.14% scored 2. The score of the osteomeatal complex on the right side had a mean of 0.2857 (SD: 0.7127), varied from 0 to 2, and 85.71% of patients scored 0, and 14.29% scored 2. Finally, the score of the osteomeatal complex in the left side had a mean of 0.2142 (SD: 0.6299), varied from 0 to 2, and 89.29% of patients scored 0, and 10.71% scored 2.

Another way to present the results of the LMS is distributing them in score categories, as shown in ►**Table 5**. A total of 15 patients (53.57%) were classified in the category from 0 to 4 points; 8 patients (28.57%) were classified in the category from 5 to 9 points; 3 patients (10.71%) were classified in the category from 10 to 14 points; and 2 patients (7.14%) were classified in the category from 15 to 24 points .

Discussion

Chronic rhinosinusitis has made many patients who have exhausted all clinical therapeutic arsenal be submitted to FESS. However, ~ 20% of patients do not exhibit significant improvement after surgery, and may require the RESS.[3] Some causes for failure in the primary surgery have been identified, but there are still only a few studies in the literature investigating the radiological findings related to RESS. In the 90's, Kennedy noticed that patients with bilateral ethmoid disease involving two other sinus on each side and patients with diffuse polyps did not have a good clinical evolution after the FESS.[12] Lazar et al verified that the most common cause for failure of the primary surgery was fibrosis and adhesion between the middle and lateral nasal turbinates.[13] Other causes of failure found by this study were recurrent polyps, middle nasal turbinate lateralization, frontal recess obstruction, persistent uncinate process, persistent Agger nasi cells, and severe septal deviation.[13]

As Musy and Kountakis pointed out, FESS has two main objectives: removing anatomical structures that may be blocking the drainage of the sinuses, and the preservation of a normal mucosa.[14] Thus, it is possible to analyze the causes of failure in the primary surgery by the analysis of the FESS goals that were not accomplished. About the resection of structures, the present study found residual Haller cells in 7.14% of patients, whereas the study by Khalil et al found them in 25.4% of patients.[11] The residual Haller cells may be a source of persistent obstruction of the maxillary sinus, which hampers a satisfactory result from the FESS. Thus, as the present study demonstrated

Table 4 Individual results of each patient in the LMS ($n = 28$)

Patient	Frontal		Anterior ethmoid		Posterior ethmoid		Maxillary		Sphenoidal		Osteomeatal complex	
	R	L	R	L	R	L	R	L	R	L	R	L
1	1	1	1	1	1	1	1	1	1	1	0	0
2	0	0	0	0	0	0	0	1	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0	0	0
4	0	0	0	0	0	0	1	1	0	0	0	0
5	1	1	1	0	0	0	1	1	0	1	2	0
6	0	0	1	1	1	1	1	1	0	0	0	0
7	1	1	0	0	0	0	0	0	0	0	0	0
8	1	1	1	1	1	1	1	1	0	0	2	2
9	0	0	1	1	1	1	1	1	1	0	0	2
10	0	0	1	1	2	2	0	0	0	0	0	0
11	0	0	0	0	0	0	1	1	0	0	0	0
12	0	0	1	1	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0	0	0
14	1	1	0	0	0	0	1	1	1	1	0	0
15	0	0	1	2	1	1	2	1	0	0	0	0
16	0	0	0	0	1	0	1	1	0	0	0	0
17	0	0	1	1	1	1	0	1	0	0	0	0
18	0	0	0	0	0	0	1	1	0	0	0	0
19	0	0	0	0	0	0	1	1	1	1	0	0
20	1	2	2	2	2	2	1	1	1	1	2	2
21	0	0	0	0	0	0	1	1	0	0	0	0
22	1	2	2	2	2	2	1	1	1	1	0	0
23	0	0	0	0	0	0	1	1	1	0	0	0
24	2	1	1	1	1	1	0	1	0	1	0	0
25	0	0	0	0	0	0	1	1	0	0	0	0
26	1	1	1	1	1	1	1	1	1	1	2	0
27	0	0	0	0	0	0	1	1	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1	0	0

Abbreviations: L, left; LMS, Lund-Mackay score; R, right.

lower rates of this residual anatomical structure, it is possible to say that the studied population was less exposed to a factor that predisposes clinical failure after surgery.

Table 5 Distribution of patients according to score categories in the LMS ($n = 28$)

Score category	N	%
0 – 4	15	53.57
5 – 9	8	28.57
10 – 14	3	10.71
15 – 24	2	7.14

Abbreviation: LMS, Lund-Mackay score.

The uncinate process was found in all patients in this study, either in its normal form (92.85% of patients) or residual form (7.14% of the patients). These rates are different from those found by Khalil et al and Musy and Kountakis, who found a residual uncinate process in 60.3% and 37% of patients respectively.[11,14] This finding indicates more preservation of this structure during primary surgery in the population from this study when compared with the one from other studies. There is a disagreement in the literature about what is the best conduct to be taken regarding the uncinate process in the FESS. Some studies say that the resection of the uncinate process is an important step in the maxillary sinusectomy.[15] Parsons et al described the "missed ostium sequence," caused by the incomplete removal of the uncinate process, as the most important cause of failure in the FESS.[16] This sequence is caused by the modification of the maxillary sinus ostium position that results in a recirculation phenomenon, in which the mucus circulates outside the natural ostium and returns to the sinus

by the middle meatus antrostomy. This process results in the obstruction of the maxillary sinus and in the return of the symptoms as a consequence.[14,16] Other studies, such as the one conducted by Nayak et al, defend the idea that the uncinate process must be preserved in the FESS. The reason would be the functional role of protecting the sinus against allergens and bacteria, acting as a physical barrier and directing the contaminated air out of the sinus.[17]

The second main objective of the FESS is the preservation of the sinus normal mucosa, and its importance is well established in the literature. The non-fulfilment of this principle may lead to scarring in areas around the sinusotomies and even to middle nasal turbinate lateralization.[14] This study found middle nasal turbinate lateralization in 10.71% of patients. This percentage is lower than the ones found by Khalil et al and Musy and Kountakis, who found it in 17.5% and 78% of patients respecively.[11,14] This may represent a more careful handling of the mucosa in the primary surgery of the patients from this population compared with the ones from other studies. Another important cause of middle turbinate lateralization is the resection, even if partial, of the middle turbinate tissue. This procedure must be reserved for a few selected cases, as for patients with large pneumatization areas in the middle turbinate.[14] Signs of middle nasal turbinate resection were found in 10.71% of patients. Even though this rate of patients does not represent a large portion of this study's population, it is not known if the resection was necessary in these cases, and there is no viable similar data in the literature for us to compare.

Some findings were observed in a significant number of patients in the literature, but were not identified in this study, or were identified in a small number of patients. In the study by Khalil et al, residual cells in the posterior ethmoid were found in 96.8% of patients, and residual cells in the anterior ethmoid were found in 92.1% of them. The study by Musy and Kountakis found residual Agger nasi cells in 49% of patients, residual cells in the anterior ethmoid in 64%, and residual cells in the ethmoid posterior in 41% of them.[14] The present study found residual ethmoidal cells in only 3.57% of patients. However, 46.42% had no signs of manipulation in the ethmoid sinus. This demonstrates the absence of resection in this structure, resulting in residual ethmoid cells. Despite the fact that our rates were lower when compared to other studies, residual ethmoidal cells were observed in a significant number of patients in the present study. This shows the preference for more conservative techniques, which may have been determinant in the surgery failure in these cases.

The study by Musy and Kountakis also found obliteration in frontal recesses in 50% of patients, and stenosis of the middle meatus antrostomy in 39% of them.[14] The study by Khalil et al found residual cells in the frontal recess in 96.8% of patients, and obstruction of the ostium of the sphenoid sinus in 68.3% of them.[11] This study identified the middle nasal turbinate lateralization with stenosis of the middle meatus in 10.71% of patients. This is a common complication, and often requires RESS to unlock the middle meatus. The present study also found frontal recess obliteration in 25% of patients, and obliteration of the sphenoethmoidal recess in 14.28% of them. These findings were identified less frequently in this study when compared to the studies conducted by Khalil et al and Musy and Kountakis. However, all of these results suggest the use of conservative techniques in the resection of structures related to the FESS.

Among the most frequent findings observed in the present study, the remaining septal deviation was found in 75% of patients. This datum contrasts with the findings of the study by Khalil et al, in which septal deviation was identified in only 15.9% of patients.[11] Other significant findings observed in this study were not found in similar studies,[11,14] such as: the mucosal thickening of the maxillary sinus in 89.28% of patients; the absence of manipulation signs in the inferior nasal turbinate in 85.71% of patients; the absence of manipulation signs in the osteomeatal complex in 75% of patients; the absence of manipulation signs in the frontal sinus in 64.28% of patients; the absence of manipulation signs in the sphenoid sinus in 60.71% of patients; mucosal thickening of the ethmoid sinus in 50% of patients; the absence of manipulation signs in the ethmoid sinus in 46.42% of patients; the pneumatization of the middle nasal turbinate in 39.28% of patients; the absence of manipulation signs in the middle nasal turbinate in 39.28% of patients; and mucosal thickening of the sphenoid sinus in 39.28% of patients.

The LMS was the method used to stage the severity of the CRS.[18] According to the study by Ashraf and Bhattacharyya, this score may range from 0 to 5, even in a clinically normal population. They also proposed that a minimum score of 4 was necessary to perform the FESS.[19] However, in the study by Hopkins et al, 20.9% of patients undergoing FESS scored between 0 and 4. This highlights that the symptom intensity must be the most important factor in the therapeutic decision. In the remaining score categories, 25.5% of patients scored between 5 and 9; 28% scored between 10 and 14; and 25.6% of patients scored between 15 and 24. The mean score found by Hopkins et al was 7 (SD: 4.7).[20] The present study obtained a mean of 5.71 (SD: 4.60) in the LMS, and most patients fell into the lowest score categories. However, in the study by Hopkins et al, only 36.3% out of 848 patients undergoing FESS by CRS were submitted to reoperations.[20] Thus, the population studied by Hopkins et al was not a homogeneous one, unlike the one in the present study.

The study by Khalil et al found pansinusitis in most patients undergoing RESS using the LMS; wherein scored 0 only 2.4%, 7.1% and 22.2% of maxillary, ethmoidal and frontal sinuses respectively. Based on this, the authors suggest that more aggressive dissections should have been used in the primary surgery of those patients.[11] In the present study, 5.35% of patients scored 0 for the maxillary sinus, 13.39% scored 0 for the ethmoidal sinus, and 33.9% scored the same for the frontal sinus. This suggests that less conservative techniques were used in the primary surgery for this study's population when compared to the study by Khalil et al.[11] Thus, it is possible to verify that the present study obtained lower rates in the LMS when compared to similar studies.[11,20]

The most studied discussion point about the tomographical findings of RESS in the literature is the use of more aggressive or more conservative techniques of resection. While some authors argue that aggressive resections would be essential to avoid failure in the FESS, others believe that the conservation of normal tissues in the sinus is the key to a good clinical outcome. According to the analysis of some structures in the present study, it is possible to infer that more conservative resection techniques were applied. Still, the number of residual structures found was very large, and some of them are related to failure in the FESS. A possible explanation for the adequate resection not having occurred during the primary surgery may be the lack of request of a preoperative CT scan for surgical planning. As the present study did not aim to assess the clinical outcome of RESS and did not have a control group, it is not possible to draw definitive conclusions. However, it is expected that, with the identification of residual structures from the FESS that may lead to clinical failure, other studies should be performed to correlate the different resection techniques with their clinical outcomes.

The present study suggests that the lack of request of a preoperative CT scan during primary surgeries may have interfered in the decision to use more conservative techniques in these patients, which resulted in the persistence of residual structures. So, one of the possibilities to explain the choice for more conservative surgical techniques that resulted in the persistence of structures that should have been removed is the lack of a CT scan during the preoperative planning. It is already well established in the literature that CT is the best imaging technique for the evaluation of patients affected by CRS.[1] Nevertheless, the experience with this study reinforced the fundamental role that CT plays in the diagnosis and therapeutic decision in cases of RESS.

Conclusion

The CT analysis in patients undergoing RESS showed findings that may be responsible for the failure of the primary surgery, with the persistence of symptoms. These findings are the result of excessive resection or the lack of it, keeping persistent structures, in previous FESS. The most significant findings were: the presence of residual septal deviation; middle nasal turbinate lateralization; a residual or not resected uncinate process; residual Haller cells; mucosal thickening of the frontal, ethmoidal, sphenoidal and maxillary sinuses; and the absence of surgical manipulation signs in these same sinuses. The level of mucosal thickening of the sinuses was verified using the LMS, and the average score was 5.71. Most patients were classified in the lower score category, between 0 and 4 points. Studies comparing the technical variants with clinical outcomes should be performed to confirm the results.

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