Endoscopic Medial Maxillectomy With Preservation of Inferior Turbinate: Assessing Results by Acoustic Rhinometry

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Background: The aim of this study is to demonstrate the effectiveness of the Endoscopic Medial Maxillectomy technique with the preservation of the nasal anatomy and function of the inferior turbinate.

Methods: From January 2005 to December 2016, the authors performed 27 Endoscopic Medial Maxillectomy with preservation of inferior turbinate on 26 patients. The most frequent pathologies diagnosed were inverted papillomas (13/27) and antrochoanal polyps (7/27). There were 21 primary lesions and 6 patients had been previously treated. There were 19 males and 7 females. On 11 patients the authors could perform an acoustic rhinometry at 4 months postoperatively.

Results: The authors did not find any recurrences. In all cases the authors note the presence of the C-notch being the narrowest area of the nasal cavity, on both the surgical and nonsurgical nasal fossa. The mean area for the C-notch in the nonsurgical nasal cavities was 0.50 cm^2 (0.18–0.82) and it was 0.57 cm^2 (0.08–1.06) in the surgical nasal cavities. The increase of the C-notch after nasal decongestion was 0.10 cm^2 in nonsurgical cavities and it was 0.03 cm^2 in the surgical cavities. The mean distance for the C-notch was 2.18 cm and 2.36 cm before and after nasal decongestion in the nonsurgical fossae. In the surgical cavities were 2.31 and 2.37 cm respectively.

Conclusions: The authors' rhinometrics data suggest that Endoscopic Medial Maxillectomy with preservation of inferior turbinate is an effective technique that preserves the anatomic structure and the functions of the inferior turbinate after its resection and reposition.

Key Words: Endoscopic sinus surgery, inferior turbinate, maxillectomy, postoperatives, rhinometry

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The surgery of the maxillary sinus has undergone an evolution along with the development of endoscopic sinus surgery. In 1651, Nathaniel Highmore made the first allusion to surgical aspects of the maxillary sinus focused on the relation between the maxillary sinuses and the teeth.[1] In 1718, Meibom[2] was probably the first to perform a surgical treatment on a maxillary rhinosinusitis. He penetrated the maxillary sinus after the extraction of a tooth and created an oro-antral fistula to drain the infected sinus. It was believed that all maxillary sinus diseases were of dental origin.

During the 18th and 19th centuries, several surgeons described the canine fossa approach as an alternative to this alveolar margin approach. Both techniques keep the fistula open for irrigation inside the sinus.[2,3] The 2 approaches were disregarded because in only few cases the symptoms were relieved. In 1882, Emil Zuckerkandl demonstrated that most of the lateral wall region of the middle meatus was membranous, and he alternatively suggested entering the maxillary sinus behind and below the infundibulum. Several surgeons such as Onodi A, Ostrum L, or Kubo I performed this approach, but it was rejected because of the severe nose bleeding and the frequency of orbital injury penetration. To avoid these side effects Johann Mikulicz in 1886, Howard A. Lothrop in 1897, and Raymond Claoue in 1902 described the inferior meatal approach.[2]

George Caldwell in 1893, Scanes Spicer in 1894, and Henri Luc in 1897 presented a combination of the antral approach with this inferior meatal method.[4] They completely removed the diseased tissue through the antral approach and then closed the incision in the gingivolabial fold. Their main contribution was to create a simultaneous counter opening into the nasal cavity. This procedure gained popularity and it was extensively used in the 20th century replacing all other methods. However, this approach side effects and the better understanding in the anatomy and physiology of the paranasal sinuses, began to change the maxillary sinus surgical treatment.

In the beginning of the 20th century several surgeons went back to the concept of the middle meatal approach to the maxillary sinus. They pointed out that removal of the middle meatus mucosa was easy, safe and with less tendency to close than the inferior meatus area. In the 1960s and 1970s the introduction of the endoscope and subsequently new technologies definitively improved these endonasal approaches and the practice of the Caldwell–Luc approach decreased considerably.[5–7]

Currently, it is the most used technique to treat most of the maxillary sinus pathology especially benign lesions. Nevertheless, the standard middle antrostomy presents some limitations. Some areas of the maxillary sinus are poorly inaccessible with a simple middle antrostomy, and there is the possibility of restenosis. Despite this between 4% and 15% closure rate for the middle antrostomy has been published.[8] To avoid these situations, in the last few years several techniques have been reported to extend the meatus antrostomy further. Our institution published one of these extended approaches named the Endoscopic Medial Maxillectomy with Preservation of Inferior turbinate (EMMPI).[9]

The aim of this study is to show this extended technique's effectiveness with preservation of the nasal anatomy and function of the inferior turbinate through by means of the acoustic rhinometry results.

METHODS

Patients and Pathologies Characteristics

From January 2005 to December 2016, we performed 27 EMMPI on 26 patients. The most frequent pathologies diagnosed were inverted papillomas (13/27) and antrochoanal polyps (7/27). The other pathologies were 2 mucoceles with maxillary tooth included in the same patient, 2 unilateral maxillary inflammatory polyps, 1 maxillary cyst, 1 dermoid cyst in the infratemporal fossa, and 1 trigeminal neurinoma in the pterygopalatine fossa.

There were 21 primary lesions and 6 patients had been previously treated, 3 of them were inverted papillomas and 3 antrochoanal polyps.

The whole of the patients were evaluated preoperatively by nasal endoscopy and computed tomography to assess tumor extension. We performed a magnetic resonance in all patients diagnosed with inverted papillomas and the cases diagnosed with a dermoid cyst and a trigeminal neurinoma. All inverted papillomas involved on any maxillary wall other than the medial wall, 12 of them had the origin in the maxillary sinus and 1 of them in the ethmoid sinus. They were classified according to Krouse staging system as T3[10] and B group according to Cannady system.[11]

Of the total population mean age at diagnosis was 52 years—old with a range between 28 and 79 years old. There were 19 males and 7 females.

On 11 patients we could perform an acoustic rhinometry at 4 months postoperatively. We used the Rhinoscan module (Rhinometrics A/S, Lynge, Denamrk; version SRE2000) for rhinometric assessment.

We use the normal values in adult patients published previously in our population. We consider an area of 0.56 cm^2 (0.44–0.68) for the C-notch situated to 1.87 cm from the nares (1.69–2.05).[12] C-notch is anatomically correlated with the head of the inferior turbinate We measured and compared both nasal cavities in each patient, the pathological (surgical nasal fossa) and the normal fossa (nonsurgical nasal fossa).

Surgical Technique

The EMMPI was performed as we described previously in 2010 with the only difference that currently we cut the head and the body of the inferior turbinate, and at the end of the surgery we pass a reabsorbable 3-0 suture through it (Fig. 1). It is important to maintain a fraction of the turbinate head insertion in the conchal crest of the frontal process of the maxillary bone to facilitate the suture.

Ethics Statement

The Institutional Review Board of Santa Creu i Sant Pau Hospital approved all protocols used.

RESULTS

In the group of patients diagnosed with inverted papilloma, 3 of them presented transient numbness in the homolateral superior maxillary bone as a minor complication. Facial pain persisted postoperatively for 2 weeks in the patient diagnosed with trigeminal neurinoma. None of the patients suffered from epistaxis or epiphora in the whole of patients. No recurrences were diagnosed with the of 1-year minimum follow-up.

We did not find any recurrences or complication in the other operated pathologies.

The mean area for the C-notch in the nonsurgical nasal cavities was 0.50 cm^2 (0.18–0.82) and it was 0.57 cm^2 (0.08–1.06) in the surgical nasal cavities. The mean area for the C-notch after nasal decongestion was 0.60 cm^2 in both groups. In all cases we note the presence of the C-notch being the narrowest area of the nasal cavity, on both the surgical and nonsurgical nasal fossa. The mean distance for the C-notch was 2.18 and 2.36 cm before and after nasal decongestion in the nonsurgical fossae. In the surgical cavities were 2.31 and 2.37 cm respectively. The measures of each nasal fossa are shown in Tables 1 and 2 (Table 1 presents 10 nasal cavities and Table 2 presents 12 nasal cavities as there is 1 patient with bilateral pathology).

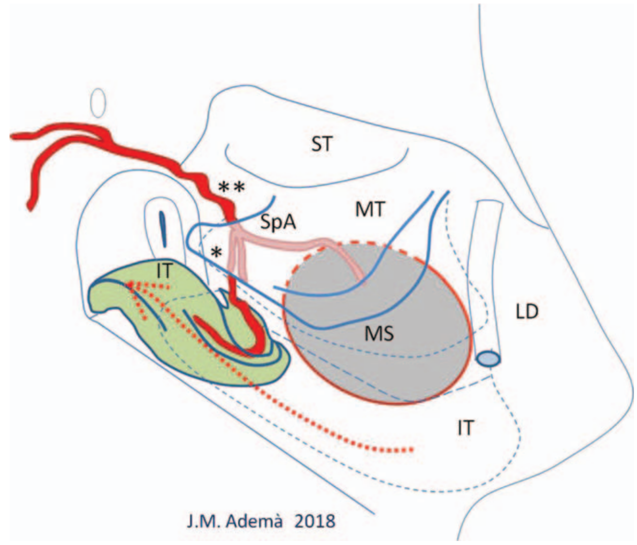

FIGURE 1. Drawing of the endoscopic medial maxillectomy with preservation of inferior turbinate technique. IT, inferior turbinate; LD, lacrimal duct; MS, maxillary sinus; MT, middle turbinate; SpA, sphenopalatine artery; ST: superior turbinate. **:posterior septal artery, *: posterolateral nasal artery.

TABLE 1. Nonsurgical Nasal Cavities

Nasal Fossa	C-Notch (cm^2)	Distance (cm)	VC C-Notch (cm^2)	VC Distance (cm)	Difference (cm^2)
1	0.34	2.30	0.51	3.31	+0.17
2	0.73	2.31	0.73	2.31	0
3	0.39	2.10	0.81	2.30	+ 0.42
4	0.70	2.30	0.73	2.70	+ 0.03
5	0.31	1.60	0.34	1.50	+ 0.03
6	0.38	2.35	0.46	2.35	+ 0.08
7	0.57	1.95	0.61	2.30	+ 0.04
8	0.26	2.30	0.46	2.30	+ 0.2
9	0.79	2.30	0.82	2.30	+0.03
10	0.54	2,35	0.58	2.30	+0.04
Mean	0.50	2.18	0.60	2.36	0.10

TABLE 2. Surgical Nasal Cavities

Nasal Fossa	C-Notch (cm^2)	Distance (cm)	VC C-Notch (cm^2)	VC Distance (cm)	Difference (cm^2)
1	0.36	2.65	0.44	2.30	+0.08
2	0.31	2.31	0.34	2.31	+0.03
3	0.47	2.65	0.45	2.65	−0.02
4	0.59	2.31	0.59	3.31	0
5	0.44	1.55	0.44	1.50	0
6	0.55	2.31	0.58	2.30	+0.03
7	0.60	2.30	0.77	2.30	+0.17
8	0.43	1.95	0.56	2.30	+ 0.13
9	0.78	1.95	0.74	1.95	−0.04
10	0.66	2.30	0.66	2.30	0
11*	1.31	2.70	1.36	2.65	+0.05
12*	0.35	2.79	0.37	2.65	+0.02
	0.57	2.31	0.60	2.37	0.03

*Patient with bilateral pathology.

DISCUSSION

At the beginning of the 20th century middle meatus approaches began to be performed instead of antral or gingivolabial approaches.[5] Currently with the aid of rigid endoscopes it is the standard surgical treatment for most of the maxillary sinus pathology. However, in same cases it is necessary to expand this approach to gain access to some nonvisible areas of the sinus. These areas include the anterior maxillary wall and especially the prelacrimal and the alveolar recess. To reach these areas open approaches or extended endoscopic antrostomies have been published. The endoscopic techniques include the medial maxillectomy with resection of the inferior turbinate, maxillary mega-antrostomy, the inferior meatus approach, and prelacrimal and postlacrimal approaches.[13–16]

In 2010, we described the Endoscopic Medial Maxillectomy with Preservation of Inferior turbinate. The objective of performing this technique was to reach the hidden areas of the maxillary sinus while maintaining the whole of the inferior turbinate in its initial position. To avoid the damage of the turbinate blood supply, we recommend locating the posterolateral nasal artery in the sphenopalatine foramen. This branch provides the posterior vascularization of the turbinate through the inferior turbinate artery. Thus, the inferior turbinate maintains its physiologic functions such as filtering, warming, and moistening inhaled air and producing the vast majority of nasal airflow resistance.

In our current and previous publications we showed no recurrences in all pathologies operated. In those patients who underwent the technique we described, we did not find excessive dryness in nasal examination (Fig. 2). Now we can objectively suggest the preserved function of the inferior turbinate through acoustic rhinometry measurements.

In 1985, Hilberg et al[17] introduced the acoustic reflectometry in the study of the nasal fossa areas and volumes trough the acoustic rhinometry. It is an easy, objective, and noninvasive technique that evaluates the geometry of the nasal cavity. This test estimates the cross-sectional area of the nasal cavity at different points of the nasal fossa. The narrowest area of the nasal cavity called the minimal cross sectional area (MCA) is located within a distance of 3 cm from the nares. In nondecongested nasal fossa 3 notches are noted. The second deflection is anatomically correlated with the head of the inferior turbinate (C-notch). In 96% of population the MCA is located at the C-notch and it is the most valuable clinical measurement.

We have focused on the second deflection (C-notch) to demonstrate the preservation of anatomy and therefore the function of the inferior turbinate. The most important area of inferior turbinate is its head. It is the key anatomical structure to preserve the nasal comfort.[18,19] Among a Caucasian population it has been stated that an MCA < 0.4 in nondecongested nose correlates with nasal obstruction.[20]

However, it is very difficult to define a normal rhinometric nasal cavity. Many variables must be taken into consideration according to ethnic characteristics, age, weight, and the various tools used. In an attempt to assess our results in the most reliable way we use the normal values in adult patients published previously in our Spanish population.[12]

The mean average area of the C-notch on the surgical nasal fossa was 0.57 cm^2.

This result suggests that the head of the inferior turbinate remains in place after its resection and reposition, and the values of these postsurgical C-notches are within the normal gap (0.44–0.68 cm^2).

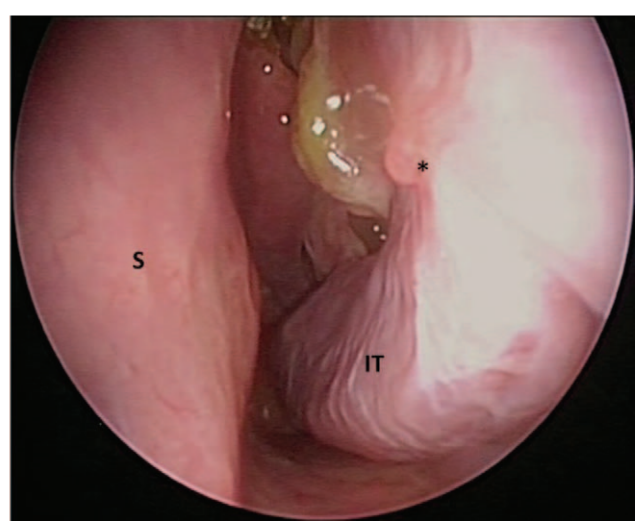

FIGURE 2. The endoscopic image of the left inferior turbinate 1 month postoperatively. *Suture point. IT, inferior turbinate; S, septum.

Comparing areas values from nonsurgical and surgical nasal cavities, we show that the surgical group presents a greater area (0.57 cm^2 versus 0.50 cm^2). The manipulation of the head of the inferior turbinate with a minor amount of mucosa removal performed using our surgical technique, is probably responsible for the C-notch being higher in these nasal cavities.

For that reason the C-notch distance was noted posterior to the normal subjects' C-notch (2.31 cm versus 1.87 cm) and to the nonsurgical nasal fossae (2.31 cm versus 2.18 cm).

The second aim of this study was to demonstrate not only the maintenance of the anatomical structure of the inferior turbinate but the preservation of the main nasal function.

After the use of the topical nasal vasoconstrictor measurements by means of the acoustic rhinometry, show a significant increase in the C-notch due to the presence of erectile tissue of the inferior turbinate. This finding consistently happens but the average size increase in the normal nasal cavity (0.10 cm^2) was superior to the postsurgical nasal cavity (0.03 cm^2).

The lesser enlargement of MCA on the surgical group after decongestion compared with the nonsurgical fossa suggests that some amount of fibrous replacement appears at the head of inferior turbinate.

One of the limitations of the study could be the lack of measurements of the geometry of the nasal cavity prior to the surgery. We believe that the presence of pathology hinders the accurate study of the inferior turbinate and its posterior comparative analysis, which is why we only test the postsurgical results.

CONCLUSION

Our rhinometrics data suggest that Endoscopic Medial Maxillectomy with preservation of inferior turbinate is an effective technique that preserves the functions and the anatomic structure of the inferior turbinate after its resection and reposition.

After resection and reposition of the inferior turbinate, the C-notch is higher and more posterior compared with normal subjects' values and with the nonsurgical fossae, but within the normal measurements.

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