# Transnasal Endoscopic Medial Maxillectomy as the Initial Oncologic Approach to Sinonasal Neoplasms

## *The Anatomic Basis*

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**Objective:** To demonstrate an anatomic basis for endoscopic medial maxillectomy with excision of the lateral nasal wall to the nasal floor, including the inferior turbinate, and nasolacrimal duct. Transnasal endoscopic medial maxillectomy involves complete resection of the lateral nasal wall with boundaries that are inferior to the nasal floor; superior to the cribriform plate and fovea ethmoidalis; anterior to the anterior maxillary wall, including the nasolacrimal duct; and posterior to within 5 mm of the eustachian tube. Transnasal endoscopic medial maxillectomy provides exposure for endoscopic resection of the orbital wall, pterygopalatine fossa, pterygoid plates, nasopharynx, and anterior skull base when indicated.

**Design:** Volumetric analysis of the maxillary sinus was performed on axial and coronal computed tomographic scans of 19 adult patients for a total of 38 maxillary sinuses.

**Setting:** Tertiary care medical center.

**Patients:** Nineteen adult patients with tumors of the head (but outside the sinonasal region).

**Interventions:** Radiographic analysis.

**Main Outcome Measures:** The total volume of the maxillary sinus, volume above and below the superior attachment of the inferior turbinate, and volume anterior to the nasolacrimal duct were measured.

**Results:** The mean (SD) total volume of the maxillary sinus was 20.1 (4.2) $cm^3$, whereas its volume inferior to the superior attachment of the inferior turbinate was 12.9 (3.7) $cm^3$ and anterior to the nasolacrimal duct was 1.1 (0.6) $cm^3$. The mean (SD) volume of the maxillary sinus inferior to the superior attachment of the inferior turbinate was 64% (12%), whereas the nasolacrimal duct obscured the transnasal anterior exposure of the maxillary sinus.

**Conclusion:** Without excision of the lateral nasal wall inferiorly to the nasal floor and anteriorly, including the nasolacrimal duct, over half of the maxillary sinus would be inaccessible for procedures directed at neoplasms within the maxillary sinus.

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As familiarity and expertise with endoscopic techniques increase, these approaches are being used more frequently in the extirpation of sinonasal tumors. Many of these lesions, including inverted papillomas, have shown favorable outcomes with transnasal endoscopic resections.[1] Traditionally, a lateral rhinotomy or sublabial degloving approach and an open medial maxillectomy have been used for resection of sinonasal tumors.[2-5] Minimally invasive endoscopic techniques have been advocated for their decreased morbidity and comparable efficacy.

Early endoscopic techniques entailed an extended maxillary antrostomy with piecemeal resection of tumor of the lateral nasal wall.[6-10] A true medial maxillectomy is not performed because the inferior turbinate and nasolacrimal duct are preserved. Therefore, in these approaches, intraoperative access to the anterior and lateral walls of the maxillary sinus is limited.

The senior author (N.S.) has already described a technique for transnasal endoscopic medial maxillectomy (TEMM).[11] In this endoscopic en bloc medial maxillectomy, the lateral nasal wall is resected to the level of the inferior meatus and anteriorly beyond the nasolacrimal canal. This

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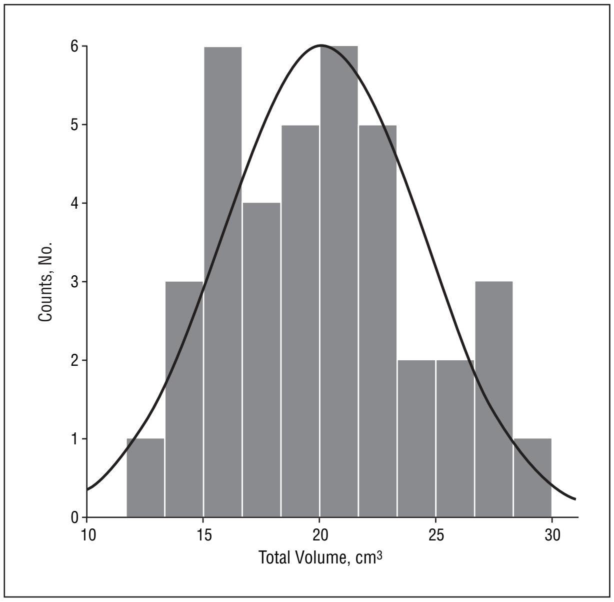


**Figure 1.** Distribution of total maxillary sinus volume for 38 maxillary sinuses. The mean (SD) total volume was 20.1 (4.2) cm$^3$.

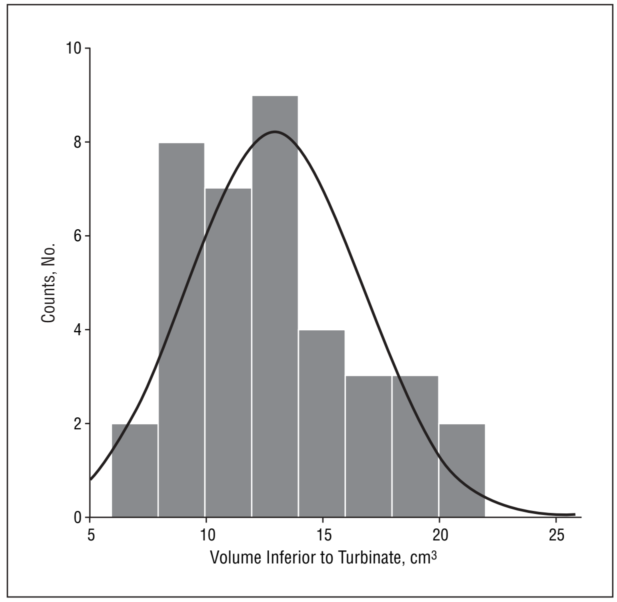


**Figure 2.** Distribution of maxillary sinus volume inferior to the attachment of the inferior turbinate for 38 maxillary sinuses. The mean (SD) total volume was 12.9 (3.7) cm$^3$.

allows for full access to the maxillary sinus, including the anterior and lateral walls, the ethmoid sinuses, and the anterior wall of the sphenoid sinus. The technique and exposure are similar to the open medial maxillectomy, except for the lamina papyracea and anterior maxillary wall that are preserved with TEMM. We determined the volume of the maxillary sinus that lies below the attachment of the inferior turbinate and anterior to the nasolacrimal duct, hence determining the limitations that these structures pose in reliable endoscopic surgical approaches to the maxillary sinus.

## METHODS

### SUBJECTS

Adult patients with tumors of the head (but outside the sinonasal region) were selected for the study. These patients had computed tomographic (CT) scans of the head in preparation for radiation therapy by the Department of Radiation Oncology, The George Washington University, Washington, DC. Volumetric measurements were performed with axial images (2.5-mm-thick cuts). Images with evidence of any sinonasal disease (inflammatory or neoplastic) were excluded from the study.

### OUTCOME MEASURES

Volumetric analysis of the maxillary sinus was conducted with Pinnacle software (ADAC Radiation Therapy Products, Milpitas, California). Values measured included the volume of the maxillary sinus inferior to a transverse line through the most superior insertion of the inferior turbinate to the lateral nasal wall (hereinafter, V1), the volume of the maxillary sinus superior to this line (hereinafter, V2), the volume of the maxillary sinus anterior to the most posterior portion of the nasolacrimal canal (hereinafter, V3), and the total volume of the maxillary sinus (hereinafter, V4).

### STATISTICAL ANALYSIS

Using Pinnacle software, 3-dimensional reconstructions were made of the axial CT scans. On the coronal reconstructions, the most superior insertion of the inferior turbinate to the lateral nasal wall was marked. Subsequently, on the axial reconstructions, the borders of the maxillary sinus in the bony windows were manually outlined above and below this level on contiguous axial CT cuts. Volumetric calculations of each of these 3-dimensional spaces were performed by the software. Similarly, the position of the most posterior portion of the nasolacrimal canal was identified on the axial reconstructions, and a mark was drawn 2 mm posterior to this. A line perpendicular to this mark was manually drawn; then all the area of the maxillary sinus anterior to this line was outlined on contiguous axial CT cuts, and V3 was calculated.

The percentages of the total maxillary sinus volume inferior to the attachment of the inferior turbinate (V5=V1:V4) and anterior to the nasolacrimal duct (V6=V3:V4]) were calculated. Statistical analysis was performed, and mean, median, and standard deviation of these values were calculated using SPSS statistical software (version 14.0.1; SPSS, Chicago, Illinois).

## RESULTS

Nineteen patients with no radiographic evidence of sinonasal disease or neoplasia were identified. Within each patient's scan, left and right sinuses were considered individually. Therefore, volumetric analysis of 38 maxillary sinuses was performed.

Both V4 and V1 carry a relatively normal distribution (**Figure 1** and **Figure 2**). Therefore, mean volumes were used for analysis. The mean (SD) V1 was 12.9 (3.7) cm$^3$, whereas the mean (SD) V2 was 7.2 (3.0) cm$^3$. The mean (SD) V3 was 1.1 (0.6) cm$^3$. The mean (SD) V4 was 20.1 (4.2) cm$^3$. The mean (SD) V5 was 64.0% (12.0%), whereas the mean (SD) V6 was 5.0% (3.0%).

## COMMENT

Transnasal endoscopic approaches for sinonasal neoplasms have been touted for minimizing perioperative morbidity and tumor recurrence.[12-16] Avoiding transfacial or craniofacial approaches spares the patient external scars and a long recovery. Intraoperatively, adjacent tissue can be closely examined with endoscopy and, if uninvolved, can be spared.[17] Additional advantages of endoscopic techniques are angled visualization and magnification of the operative field, which allow a better view of the depths of the nasal cavities and sinuses.

A series by Lawson et al[18] of 30 patients with inverting papilloma (12%) demonstrated a low recurrence rate after endoscopic resection. Those authors, however, limited the use of their technique to inverting papillomas originating from the ethmoid, sphenoid, or medial wall of the maxillary sinus. Other surgeons have also cited tumors involving the anterior, inferior, or lateral maxillary sinus as limitations to the endoscopic approach.[6-9] When used in these difficult areas, higher recurrence rates have been reported, secondary to poor visualization.[19] However, other authors do not site maxillary sinus involvement as a limitation.[7,11]

As previously described by the senior author (N.S.),[11] TEMM is a reproducible method of accessing these difficult areas. It is a true medial maxillectomy, involving resection of the entire lateral nasal wall. Others[16] have supported this notion that an endoscopic medial maxillectomy is completed only with resection of the medial wall of the maxilla (including the inferior turbinate) up to its anterior wall.

Resection of the lateral nasal wall to the level of the inferior meatus and anteriorly beyond the nasolacrimal canal is required to gain full access to the maxillary sinus during endoscopic medial maxillectomy. The anatomical basis for this resection is demonstrated in our results. With approximately 64% of the maxillary sinus lying below the level of the inferior turbinate, complete access is possible only with lateral nasal wall resection to the floor. Approximately 5% of the total maxillary sinus volume lies anterior to the nasolacrimal canal. Resection anterior to this structure will foster visualization. As shown in a cadaveric resection in **Figure 3** and an endoscopic visualization of the maxillary sinus following TEMM in **Figure 4**, TEMM allows for a wide view of the posterior, anterior, lateral, inferior, and superior borders of the maxillary sinus. Sinonasal tumors involving the floor of the maxillary sinus are also amenable to extirpation with this technique. This is also the case when the floor is substantially inferior to the nasal floor (**Figure 5**). With this wide exposure, extended endonasal endoscopic approaches can be employed for resection of tumors or other diseases that go beyond the maxillary sinus.

Medial maxillectomy, with either an open or endoscopic approach, should allow for resection of the maxillary and ethmoid sinuses, along with the entire lateral nasal wall. When using TEMM, the technique should be a reproducible one that respects oncologic principles. Use of TEMM as outlined by the senior author (N.S.) should allow for a complete and en bloc resection of the lateral

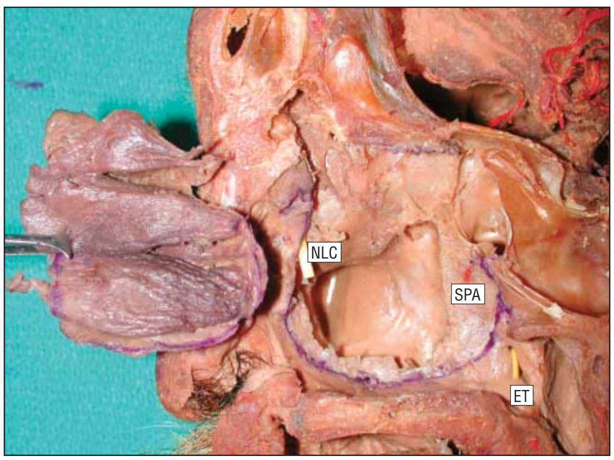


**Figure 3.** Cadaveric resection of the lateral nasal wall via transnasal endoscopic medial maxillectomy demonstrating the defect and specimen. ET, NLC, and SPA indicate eustachian tube, nasolacrimal canal, and sphenopalatine artery, respectively.

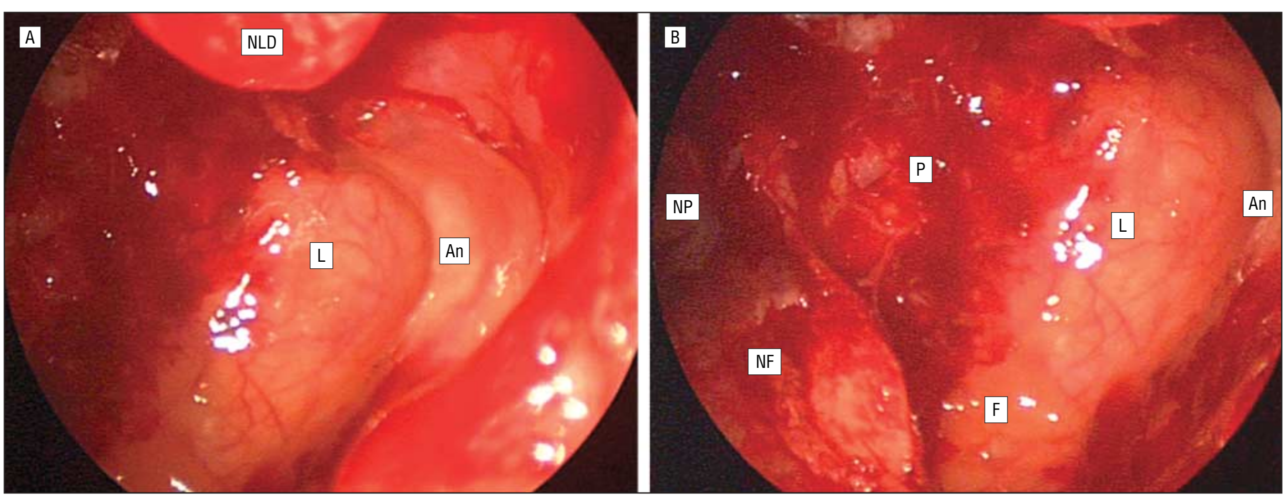


**Figure 4.** Intraoperative transnasal endoscopic view. A, The anterior (An) and lateral (L) maxillary walls and nasolacrimal duct (NLD) stump are shown. B, The floor of the maxillary sinus (F) is also visible when it is positioned below the nasal floor (NF) with a 0° endoscope. Note the nasopharynx (NP) and anterior (A), lateral (L), and posterior (P) maxillary walls.

**Figure 5.** Coronal T1-weighted magnetic resonance image with gadolinium of the same patient as shown in Figure 4, showing the maxillary sinus floor extending below the level of the nasal floor.

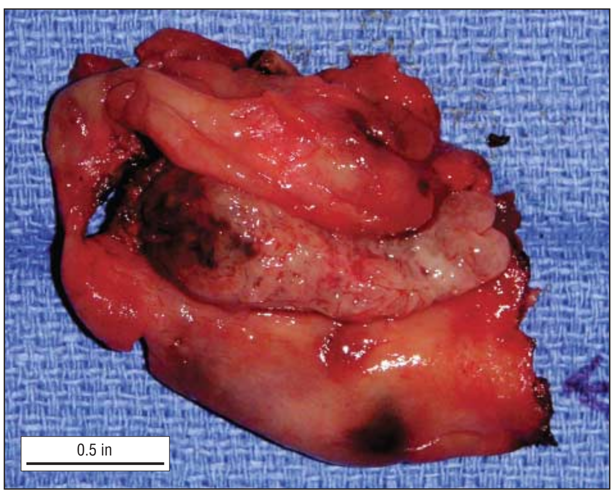


**Figure 6.** En bloc specimen after transnasal endoscopic medial maxillectomy.

nasal wall with clear margins around the tumor.[11] Often, a well-oriented, single specimen can be submitted for margins with this technique (**Figure 6**). In addition, it should provide wide access for extended resections when indicated.

In conclusion, 64% of the volume of the maxillary sinus is inferior to the lateral insertion of the inferior turbinate on the lateral nasal wall. The nasolacrimal canal prevents endoscopic visualization and access to the anterior maxillary sinus wall. Resection of the lateral nasal wall to the inferior meatus and anteriorly to include the nasolacrimal canal is required for proper access to the maxillary sinus during transnasal endoscopic medial maxillectomy. This technique is an effective, reproducible technique for treatment of sinonasal tumors and other aggressive disease processes.


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