# Infraorbital nerve transposition to expand the endoscopic transnasal maxillectomy

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***Background:*** The infraorbital nerve (ION) is a terminal branch of the maxillary nerve (V2) providing sensory innervation to the malar skin. It is sometimes necessary to sacrifice the ION and its branches to obtain adequate maxillary sinus exposure for radical resection of sinonasal tumors. Consequently, patients suffer temporary or permanent paresthesia, hypoestesthia, and neuralgia of the face. We describe an innovative technique used for preservation of the ION while removing the anterior, superior, and lateral walls of the maxillary sinus through a medial endoscopic transnasal maxillectomy.

***Methods:*** All patients who underwent transnasal endoscopic maxillectomy with ION transposition in our institute were retrospectively reviewed.

***Results:*** Two patients were identified who had been treated for sinonasal cancers using this approach. No major complications were observed. Transient loss of ION function was observed with complete recovery of skin sensory perception within 6 months of surgery. One patient referred to a mild permanent anesthesia of the upper incisors. No diplopia or enophthalmos were encountered in any of the patients.

***Conclusion:*** The ION transposition is useful for selected cases of benign and malignant sinonasal tumors that do not infiltrate the ION itself but involve the surrounding portion of the maxillary sinus. Anatomic preservation of the ION seems to be beneficial to the postoperative quality of life of such patients. 

*Key Words:*
endoscopic endonasal approach; infraorbital nerve; maxillary sinus; maxillectomy; sinonasal cancer

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The infraorbital nerve (ION) is a terminal branch of the maxillary nerve (V2)[1] originating in the pterygopalatine fossa once the latter exits the skull base through the rotundum foramen. The ION then enters the inferior orbital fissure and runs on the floor of the orbit via the infraorbital canal, reaching the infraorbital foramen anteriorly. It is responsible for sensory innervation to the skin of the malar area between the lower eyelid and the upper lip.

Injury to the ION may lead to temporary or permanent paresthesia, hypoestesthia, and neuralgia of the face.[2] Traditionally, the maxillary sinus has been accessed by way of external approaches such as those described by Caldwell[3] and Luc,[4] lateral rhinotomy, and the midfacial degloving approach.[5] However, in the course of such approaches, especially during removal of the maxillary roof, there occurs the possibility of ION damage.

Over the last decade the transnasal endoscopic maxillectomy has been validated as the standard treatment for most benign[6] and some selected malignant tumors of the sinonasal tract arising from or extending to the maxillary sinus.[7–12] It avoids external incisions and the major complications resulting from traditional approaches. Nevertheless, in some cases, the sacrifice of the ION and its branches may be necessary for adequate sinus exposure and radical

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resection of tumors. In this report we describe the endoscopic transnasal ION transposition, an innovative technique used for preservation of the nerve during removal of the anterior wall, the roof, and part of the lateral wall of the maxillary sinus, after a medial maxillectomy.

## Surgical Technique

### Preparation

The extent of the patient's disease is assessed preoperatively using nasal endoscopy and radiologic studies, which includes computed tomography (CT) and contrast-enhanced magnetic resonance (MR). Patients with a diagnosis of malignant tumor complete their staging with a total body CT scan and neck ultrasound. Surgery is performed with the patient under hypotensive general anesthesia. The nasal cavities are packed with pledges soaked in a 2% oxymetazoline, 1% oxybuprocaine, and epinephrine (1/100,000) solution, for 10 minutes. Rod lens 0- and 45-degree endoscopes of 4 mm diameter are used (Karl Storz, Tuttlingen, Germany).

### Exposure

A wide middle meatal antrostomy is performed to expose the maxillary sinus and intramaxillary landmarks such as the posterior wall of the maxillary sinus, the ION, and the inferomedial angle of the orbit. After complete ethmoidectomy, a wide sphenoidotomy is performed to identify the intrasphenoidal impression of V2, which is the inferior limit of the cavernous sinus. The turbinal branches of the sphenopalatine artery are identified and cauterized to prevent bleeding. A vertical mucosal incision is performed with a diode laser along the maxillary line from the insertion of the middle turbinate down to the nasal floor. From this point, a second mucosal incision is continued posteriorly in the inferior meatus, to as far as the junction between the soft and hard palate. The nasolacrimal duct is isolated and transected below the sac and the medial wall of the maxillary sinus with the inferior turbinate is removed. During the inferior osteotomy, it is important to identify the junction between the palatine bone and the posterior maxillary wall to avoid injury to the descending palatine artery.

The nasal vestibule is incised in a vertical slightly curved fashion, exposing the bone of the pyriform aperture. The periosteum and soft tissue enveloping the anterior wall of maxillary sinus are dissected with an elevator as far as the infraorbital foramen. The pyriform crest is drilled out with a diamond burr. The anterior wall of the maxillary sinus is removed as far as the ION, or even more laterally. Usually, the superior limit of the dissection is determined by the horizontal plane passing through the infraorbital foramen, so as to avoid injury to the ION and violation of the orbital content.

The posterior wall of the maxillary sinus is drilled out and then removed with Kerrison roungers in a medial-to-lateral direction, thus exposing the periosteal layer of the pterygopalatine and infratemporal fossa.[13] The foramen rotundum and V2 are identified laterally and superior to the vidian nerve. The inferomedial angle of the orbit and the superior wall of the maxillary sinus are then removed to unroof the ION from its exit at the rotundum foramen to its emergence on the soft tissues of the premaxillary region. Once the bony infraorbital canal is completely removed and the ION is skeletonized, it is possible to transpose the nerve, thus allowing removal of the portion of the orbital floor placed laterally to the ION course. This approach also makes it possible to reach the lateral wall of the maxillary sinus, which can be drilled out as far as the zygomatic arch when necessary (Figure 1). These deep-lateral walls of maxillary sinus are removed by drilling out the bone, obtaining a thin, bony shell that is finally removed with curved dissectors. At the end of the procedure, what remains intact is the inferior maxillary wall and the residual portion of the lateral one. The mucosa over these walls is completely removed using curved and double curved dissectors as well as small cotton pledges.

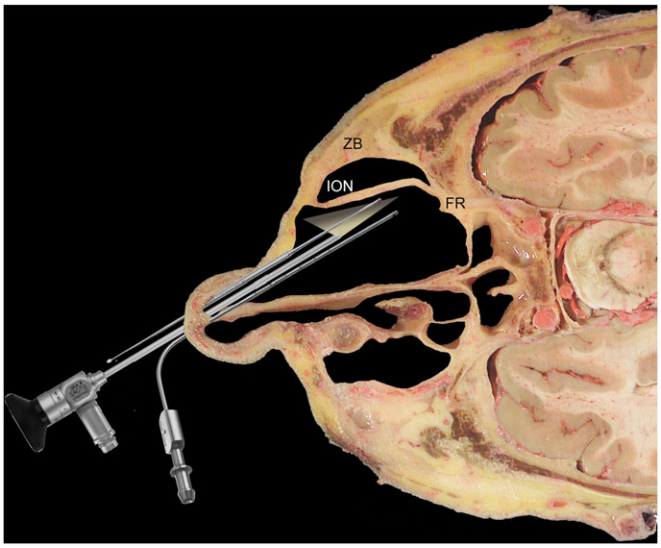


**FIGURE 1.** Anatomic diagram showing the position of the endoscope and surgical instruments, after endoscopic transnasal partial maxillectomy. The infraorbital nerve has been completely skeletonized, from the foramen rotundum to the premaxillary soft tissues. FR = foramen rotundum; ION = infraorbital nerve; ZB = zygomatic bone.

## Case 1

A 60-year-old man presented with swelling of the left maxilla and epistaxis for a poorly differentiated squamous cell carcinoma of the left maxillary sinus. At our center, the treatment protocol for poorly differentiated epithelial tumors of the sinonasal tract includes induction chemotherapy to separate responder patients, who are candidates for concurrent chemoradiation, and nonresponder patients, who are candidates for multimodal therapy.[14,15] The patient was therefore submitted for induction chemotherapy (TPF scheme). The contrast-enhanced MR scan performed after treatment showed a lack of response to induction

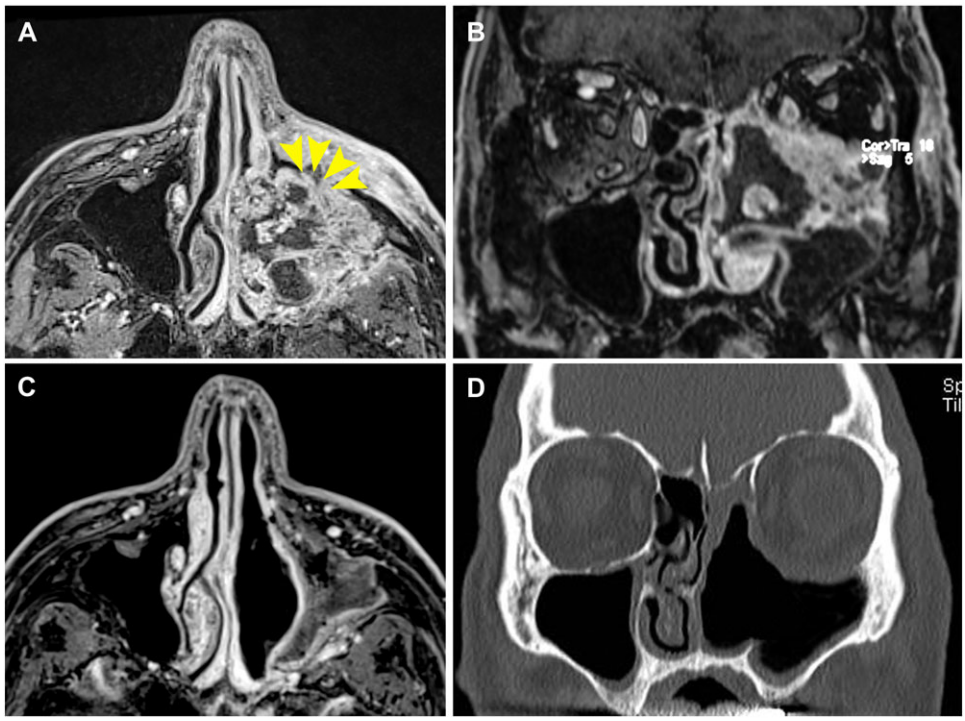


**FIGURE 2.** Preoperative axial (A) and coronal (B) magnetic resonance imaging with contrast enhancement showing the persistence of a left maxillary squamous cell carcinoma (case 1) eroding the anterior wall of the sinus (yellow arrows) without soft tissue involvement. Postoperative contrast-enhanced magnetic resonance imaging with axial view (C) demonstrates the radical resection of the tumor. The isointense signal on the surgical bed is compatible with scar tissue related to the surgical procedure, given the lack of contrast enhancement uptake. The postoperative coronal CT scan (D) highlights the removal of the bony orbital floor and the inferomedial angle of the orbit (left side). Herniation of the orbital content and the enophthalmos are avoided by preserving the periobital layer.

chemotherapy, with a persistent lesion in the left maxillary sinus (Figure 2A and B).

After a multidisciplinary tumor board discussion, the patient was submitted for surgery using an endoscopic endonasal approach. A left transnasal medial maxillectomy was extended to the anterior and superior wall of the maxillary sinus. During the operation the ION transposition was performed as previously described (Figure 3). Intraoperative frozen sections of the surgical margins confirmed the radical resection of the tumor while preserving the ION. The patient was discharged 4 days after surgery complaining of only mild paresthesia and hypoesthesia of the upper lip and upper teeth. The final histology report diagnosed poorly differentiated squamous cell carcinoma, staged yT3N0M0, and confirmed the radical resection of the tumor. Adjuvant intensity–modulated radiotherapy (IMRT) was delivered on the surgical cavity (66 Gy) as well as to the neck lymph nodes (levels from 1 to 3 on the left side and retropharyngeal nodes, 54 Gy). The postoperative contrast-enhanced MR and CT scan performed 1 year after the multimodal treatments confirmed the radical resection of the tumor (Figure 2C and D), and endoscopic evaluation showed complete healing of the surgical cavity (Figure 4). After a 15-month follow-up, the patient is free of disease and ION function was completely restored. No diplopia or enophthalmos were encountered.

## Case 2

An 80-year-old man presented with right epistaxis recurrent over 1 year. He was a retired woodworker. The CT scan and the contrast-enhanced MR scan revealed a right sinonasal mass involving the ethmoid cells and right maxillary sinus (medial wall). Neck ultrasound and total body positron emission tomography CT scan ruled out any systemic dissemination of disease. The biopsy of the lesion indicated compatibility with an intestinal-type adenocarcinoma, signet-ring cells variant. The patient was submitted for an endoscopic resection with transnasal craniectomy extended bilaterally to both the ethmoid complexes and including removal of the nasal septum. Intraoperative frozen sections were positives at the medial, anterior, and lateral maxillary walls and therefore an expanded transnasal maxillectomy with transposition of the ION was performed (see Video 1 and Video 2 in Supplementary Materials). The anterior skull base was repaired with fascia lata in a multilayer fashion. The final histology report confirmed radical resection of the lesion and staged the tumor as pT3N0M0. Adjuvant IMRT (62 Gy) was then delivered on the surgical bed. The contrast-enhanced MR scan performed 6 months after treatment excluded local recurrences of disease. Restoration of ION function was achieved within 6 months of surgery, with only a mild anesthesia of the upper incisors

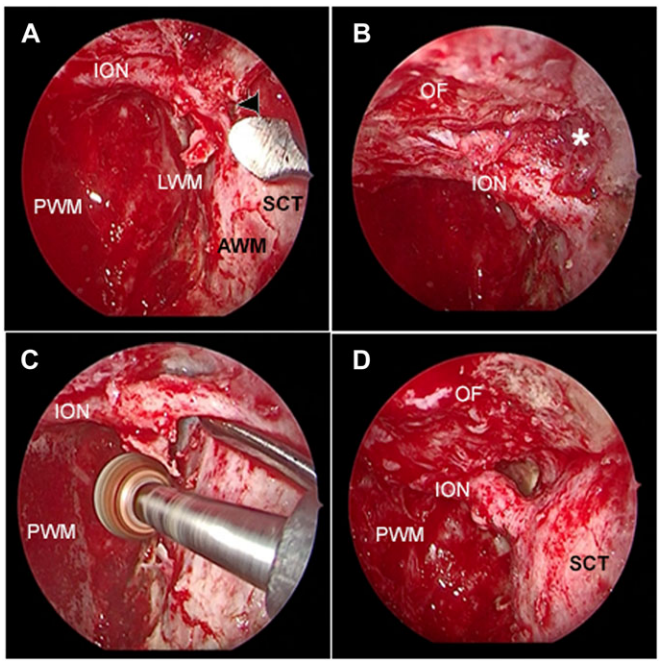


**FIGURE 3.** Step-by-step endoscopic endonasal infraorbital nerve transposition (case 1). (A) Intraoperative view after performing an endoscopic endonasal medial maxillectomy (left side) with removal of the pyriform aperture and the bony anterior maxillary wall. (B) The infraorbital nerve was unroofed from its canal as far as its emergence on the premaxillary soft tissues. (C) A high-speed diamond burr is used to drill out the bony floor of the orbit laterally to the infraorbital nerve course as well as the lateral maxillary wall. A dissector is used to elevate and displace the skeletonized infraorbital nerve. (D) Final endoscopic endonasal view of the infraorbital nerve when fully isolated. AWM = anterior wall of the maxillary sinus; ION = infraorbital nerve; LWM = lateral wall of the maxillary sinus; OF = orbital floor; PWM = posterior wall of the maxillary sinus; SCT = subcutaneous tissues of the premaxillary region. The white asterisk shows the tumor.

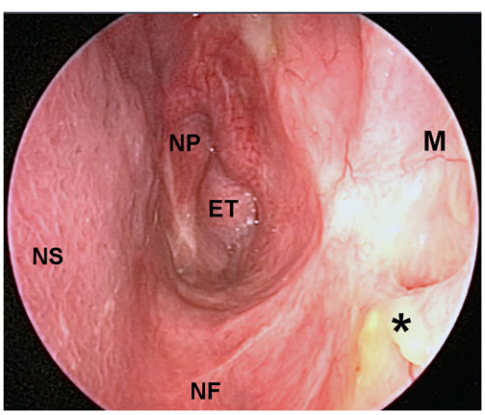


**FIGURE 4.** Postoperative endoscopic view of the maxillary cavity 1 year after endoscopic transnasal partial maxillectomy.

related to the injury of the anterior superior alveolar nerve. No diplopia or enophthalmos were encountered.

## Discussion

Traditional external surgical techniques are generally used for tumors extensively involving the maxillary sinus with erosion of its lateral and/or inferior walls. However, they are associated with complications such as epiphora, dental pain, dacryocysitis, mucocele, external scarring, paresthesia in the V2 territory, and cosmetic deformity. Consequently, they should be reserved only for selected tumors that are not amenable to less invasive approaches. All these surgical techniques may cause injury to the ION. Damage to this nerve results in paresthesia, hypoesthesia, and neuralgia of the skin of the lower eyelid, cheek, nasal ala, lip (skin and mucosa), alveolar mucosa, and gums.[16]

Recent literature describing the endoscopic medial maxillectomy and its variations for approaching the maxillary sinus has endorsed this method as a successful treatment for inflammatory conditions as well as for benign lesions and certain selected malignant tumors. We present an alternative method for approaching the anterior and lateral portion of the maxillary sinus through an endoscopic assisted endonasal approach in which the ION is skeletonized, transposed, and thus preserved. This technique is useful for selected cases of benign and malignant tumors of the maxillary sinus that do not infiltrate the ION itself but involve the surrounding portion of the maxillary sinus (mucosa of the anterior, superior and lateral walls). In our experience with this approach, we have observed only transitory loss of function of the ION, with complete restoration of the skin's sensory perception within 6 months of surgery. In only 1 patient (case 2), a mild anesthesia of the upper incisors was observed. This was probably related to the intraoperative injury of the anterior superior alveolar nerve, a collateral branch of the ION. Regarding the possibility of orbital sequelae, the integrity of the periorbit does not allow the orbital content to expand and protects the patient from diplopia and enophthalmos, thus no reconstruction of the orbital walls is required.[17,18] This approach is contraindicated for adenoid cystic carcinomas of the maxillary sinus, given their high propensity for perineural spread, as well as for malignant tumors directly invading the ION canal or infiltrating the nerve itself. Here, the resection of the ION, including the skin with the cutaneous branches of the ION affected, is mandatory to obtain a radical resection.

To the best of our knowledge, this is the first report describing transposition of the ION during an endoscopic endonasal approach for resection of lesions involving the maxillary sinus. In conclusion, the ION transposition during expanded endoscopic endonasal approaches is a feasible and minimally invasive technique for addressing the anterior and lateral portion of the maxillary sinus in well-selected cases. Anatomic preservation of the ION seems to offer benefits to the postoperative quality of life of such patients. Further functional studies are necessary to quantitatively evaluate tactile, thermic, and pain sensitivity, and to prove the real benefits of this technique compared with traditional external approaches for approaching the anterior and lateral aspects of the maxillary sinus.

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