


The ‘Maxillary Pull-through’ Technique: A Minimally Invasive Endoscopic-Assisted Approach to Nasal Septum Neoformations with Maxillary Bone Infiltration

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Paolo Priore, MD, PhD¹, Filippo Giovannetti, MD, PhD¹, Andrea Battisti, MD¹, Danilo Di Giorgio, MD¹ , Marco Della Monaca, MD, PhD¹ , Ingrid Raponi, MD¹, Andrea Cassoni, MD, PhD¹, and Valentino Valentini, MD, DMD¹

Abstract

Study Design: Description and validation of a surgical technique.

Objective: En-bloc maxillectomy with removal of the nasal septum is a rare procedure; preservation of the nasal bones and integrity of the alveolar ridge is even rarer. These procedures traditionally required a combined transfacial-transoral approach based on lateral rhinotomy. We describe a combined endoscopic transnasal-transoral approach for treatment of nasal septal malignancies that involve the hard palate.

Methods: Excision of malignant tumours arising from the nasal septum was achieved in 4 patients using a transnasal-transoral endoscopic approach. Using 4-mm optics angled at 0° and 30°, the septum was freed from the ethmoid and removed *en-bloc* with the hard palate, by pulling the septum down through the hard palate.

Results: Of the 4 patients, 2 underwent complete removal of septal chondrosarcomas, one removal of a sinonasal undifferentiated carcinoma and one removal of a mucoepidermoid carcinoma. In two cases, the palatal mucosa was spared and repositioned to restore separation between the nose and oral cavity. The remaining two cases underwent complete resection of the hard palate; one palate was reconstructed using a pedicled temporalis muscle flap and the other by employing an obturator. No infection was encountered. Partial ethmoidectomy was performed in all four cases. The mean hospital stay was 5 days. All patients are free of disease after a mean follow-up of 4 years (range: 2–7 years).

Conclusions: Our new approach allows for minimally invasive resection of nasal septal malignancies that extend to the palate. Our maxillary pull-through technique is a valuable new surgical procedure for malignant pathologies of the nasal septum; the only drawback is that endoscopic surgery has a steep learning curve.

Keywords

endoscopy, nasal tumour, septal tumour

Introduction

Maxillectomy that creates a type VIa deficit, as defined by Brown,¹ requires a combined transfacial-transoral approach based on lateral rhinotomy. Over the past 30 years, endonasal endoscopic surgery has been widely performed.^{2–7} An endoscopic endonasal approach can be used to remove intranasal malignancies that meet certain criteria. The procedure avoids facial scarring, is associated with rapid healing and recovery and facilitates early adjuvant therapy. We hypothesised that endoscopic endonasal surgery via a transoral approach would facilitate type VIa Brown maxillectomy¹ of a nasal septal malignancy that infiltrated the

palate. This method would have all of the aforementioned benefits of endoscopy, and the integrity of the alveolar ridge and the anterior wall of the maxilla would be assured. It appears that maxillary pull-through could be employed to

¹Department of Oncological and Reconstructive Maxillo-Facial Surgery, “Sapienza University of Rome”, Rome, Italy

Corresponding author:

Danilo Di Giorgio, Department of Oncological and Reconstructive Maxillofacial Surgery, “Sapienza University of Rome”, Viale del Policlinico 155 Italy, Rome, RM 00186.

Email: danilo.digiorgio@uniroma1.it

Table 1. Summary of personal data of treated patients.

Sex	Age	Histotype	TNM	A.t.	Follow-up
M	70	SNUC	pT4a R0	CRT	3y. FOD
M	45	M.C.	pT3 G3 R0	RT	2y. FOD
F	69	L.g Chondrosarcoma	\	FU	7y. FOD
F	77	H.g Chondrosarcoma	\	RT	4y FOD

A.t.: adjuvant treatment; CRT: chemoradiotherapy; RT: radiotherapy; FU: follow-up; FOD: free of disease; DWD: died without the disease.

remove the surgical specimen (by sliding it through the maxillary alveolar ridge outside the mouth). Here, we describe our new surgical procedure and provide a preliminary report of its utility.

Materials and Methods

Working in the Unit of Oncological and Reconstructive Maxillofacial Surgery of Sapienza University of Rome from January 2013 to December 2020, we encountered 4 patients (2 males and 2 females) with lesions of the nasal septum accompanied by hard palate infiltration. The mean patient age was 65 years (range: 45–77 years). The observed signs and symptoms were nasal obstruction (all patients), headache (2 patients), and facial pain (one patient). One patient had been referred because of cacosmia. All patients underwent diagnostic endonasal endoscopy at their first visits. Then, in line with our protocol, they underwent both enhanced computed tomography and magnetic resonance imaging, followed by biopsy. Tumours diagnosed prior to 2017 were restaged by our tumour board with reference to the TNM classification of the American Joint Committee on Cancer (AJCC) (2017) (Table 1).

Surgical Technique

Surgery was conducted with patients under general hypotensive anaesthesia induced by oral intubation. All patients were placed supine with the torso flexed at about 30° and the head rotated towards the operator at approximately 15°. Sponges were used to apply a local decongestant and anaesthetic to the nasal mucosa; this created room for the instruments and minimised local pain. Under visualisation using a 4-mm 0° rod-lens endoscope, surgery commenced with tumour debulking (to locate the pedicle and clear the nasal surgical corridors). Once bleeding had ceased and the surgical view was clear, the sphenoidal ostium was located bilaterally (this was 1 cm above the choana posterior to the superior turbinate tail). This served as the posterior edge of resection. Then, the septal artery was identified, this ran between the inferior border of the sphenoidal ostium and upper edge of the choana. The artery was meticulously cauterised and transected to free the septum from its

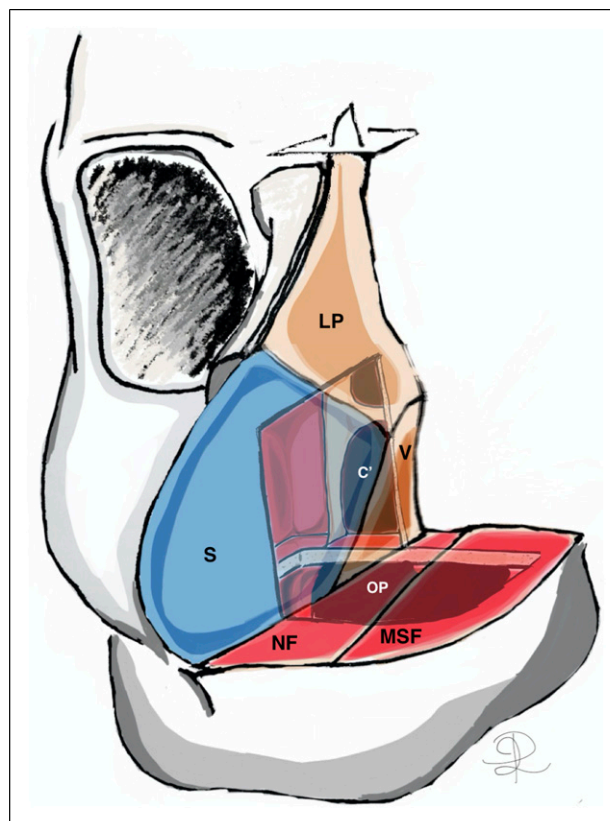


Figure 1. Drawing representing a possible type VIa maxillary resection according to Brown classification (S: nasal septum; NF: nasal floor; MSF: maxillary sinus floor; LP: lamina perpendicularis; V: vomer; C': contralateral choana; OP: oropharynx).

posterior mucosal connection. This step reduced subsequent bleeding. We then performed bilateral sphenoidotomy to detach the vomer and perpendicular lamina from the sphenoid; this ensured that the posterior border of the nasal septum was completely free. The 0° optic was then switched to a 4 mm 30° optic; this improved visualisation of the lateral 'blind spot'. To maintain as clean a surgical field as possible, surgery must proceed laterally to medially in a centripetal manner. Thus, if lateral tumour spread is evident, medial maxillectomy must be performed. This commenced with uncinectomy followed by antrostomy. The descending palatal artery and inferior turbinate artery were exposed, ligated and transected. Then, the mucosa was incised from the palatine bone towards the vomer; this removed the mucosal connection between the nasal floor and soft palate. Using a high-speed drill, the anterior component of the medial maxillectomy was completed via meticulous exposure of the naso-lacrimal duct, which was then sharply and diagonally cut to avoid stenosis. The mucosa was then cut anterior to the inferior turbinate head, down to the nasal floor and horizontally to the septum. This step can be bilateral if necessary. However, if the tumour exhibits lateral

spread to only one side (or no lateral spread at all), a lateral mucosal incision is created below the Hasner valve after resection of the nasal floor and medial maxillary wall. The anterior and posterior mucosal nasal floor cuts are similarly created. The next step is anterior septotomy within 1 cm of the tumour, sparing as much of the septum as possible to avoid nasal dorsum collapse. A superior septotomy was then performed to release the nasal septum from the anterior skull base. In other words, the anterior and posterior septal cuts were joined; this was the last step of the endoscopic procedure. At this point, surgery proceeded with adherence to the principles of disassembling endoscopic resection. The ethmoid bone was removed and endoscopic craniectomy was performed if necessary. The extent of intraoral dissection depends on the degree of palatal infiltration. If the tumour has not eroded the oral cortex, the palatal mucosa can be spared and elevated. However, if erosion is obvious, or if the images are unclear, the mucosa is removed *en-bloc* with the palatal bone. The area to be removed is incised using monopolar electrocautery. This creates a path for the osteotomies that follow, which can be performed using piezosurgical techniques or a high-speed drill. If desired, endonasal endoscopic control is possible. On completion, the sample is removed by sliding it through the maxillary alveolar ridge (outside the mouth). Then, multiple frozen sections are prepared to assess intraoperative radicality (Figure 1-3).

In one case with a sinonasal undifferentiated carcinoma (SNUC), resection had to be extended to the floor of the sphenoidal sinus to ensure a clear margin. The palatal defect can be closed by suturing back the palatal mucosa (if available) or using one of the pedicled or free flaps described in the literature. Eventually, any cranial base defect must be restored using a fascia lata graft placed using the multilayer technique.^{8,9} During endonasal dissection, high-flow bleeding can occur when branches of the sphenopalatine artery are transected for surgical reasons or accidentally damaged. To minimise intraoperative bleeding, it is essential to be familiar with the nasal vascularisation pattern. High-risk sites for arterial bleeding include the area limited by the middle turbinate and posterior horizontal end of the lamella of the superior turbinate where the sphenopalatine foramen is located; the points of turbinate insertion into the lateral nasal wall where branches of the posterior lateral nasal artery enter the turbinates; and the area between the superior border of the choana and inferior border of the sphenoidal ostium where the posterior septal artery is located. We manage bleeding by bipolar electrocautery, both standard bayonet and pistol devices. If a mass bleeds readily, or if a patient has thrombocytopenia or any defect in platelet aggregation, we suggest that surgery should begin with identification of the sphenopalatine foramen and clipping of the posterolateral nasal and septal arteries at this level. Haemostatic materials are useful if focused low-flow

bleeding is encountered; these promote platelet aggregation and stable clotting. Warm saline irrigation is useful for managing diffuse and venous 'low-flow' bleeding.

Results

All histological diagnoses were confirmed in this study. The 2 female patients had nasal septum chondrosarcomas; one male had an SNUC and the other a mucoepidermoid carcinoma. The chondrosarcomas were restaged (according to AJCC 2017) as pT1. The SNUC was staged as pT4a R0, because the tumour infiltrated the floor of the sphenoidal sinus. The mucoepidermoid carcinoma was staged as pT3 G3 R0. In one of the two cases of chondrosarcoma, the pathologists drew our attention to the posterior margin of the tumour; this had an invasive front with cellular islands dispersed in the mucous epithelium, suggesting that the surgical margins were close. The other three cases exhibited negative margins. The patients with an SNUC and mucoepidermoid carcinoma underwent total palatal resection. In one case, reconstruction involved the placement of a pedicled temporalis muscle flap. The other case had a history of cocaine abuse; we thus preferred an obturator. In the other two cases, the palatal mucosa was preserved. In one case, the mucosa was perforated during dissection, creating an oronasal fistula with a diameter of less than 1 mm; this was closed via secondary intention 2 months later. No infection or other complication was reported. No patient developed a latero-cervical metastasis during follow-up, and none required prophylactic or therapeutic functional neck dissection, either initially or during follow-up. The mean hospital stay was 5 days (range: 4–7 days). The mean follow-up (to December 2020) was 4 years (range: 2–7 years); all patients were free of disease (FOD).

Discussion

Endoscopic approaches have greatly aided head-and-neck surgery not only because endoscopic surgery alone can be effective, but also because it can enhance the outcomes of associated traditional surgery. Beginning in the early 2000s, great progress has been made in terms of the treatable pathologies and approaches.^{3,7,10–12} As well as benign tumours, malignant pathologies can be treated with complete adherence to the principles of oncological radicality. A combination of two or more endoscopic approaches is termed a multiportal approach. A multiportal combined approach is a combination of an endoscopic endonasal approach with a traditional transfacial or transoral approach. The first report of a combined transnasal/transoral endoscopic approach was that of El-Sayed et al¹³; who managed the craniovertebral junction. This was followed by many multiportal approaches employing endonasal endoscopic methods and transoral robotic surgeries. However, the high

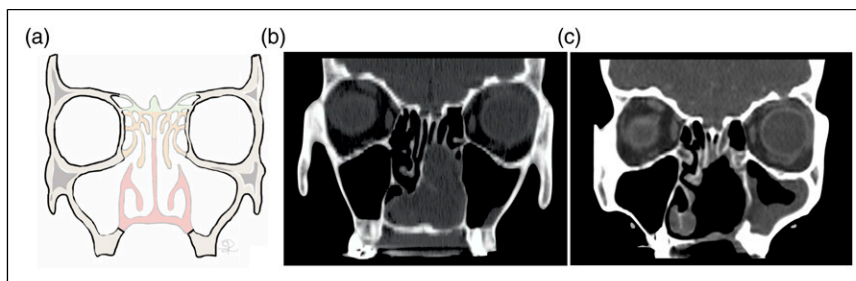


Figure 2. A) Drawing shows three grades of resection, nasal septum and hard palate in red, partial ethmoidectomy in orange and total ethmoidectomy in green. B) Preoperative CT scan showing a chondrosarcoma involving the hard palate and partially the left ethmoid. C) Post-operative CT scan showing resection of the nasal septum, the hard palate, the left inferior turbinate and left partial ethmoidectomy. It was not necessary to perform a medial maxillectomy as the frozen sections performed on the lateral portion of the nasal mucosa were free from neoplastic infiltration. Note the palatal mucosa preservation.



Figure 3. Clinical case example: a) hard palate in preoperative time. b) Post-operative surgical wound notes the sparing of the alveolar ridge. c) Post-operative image with obturator prosthesis.

costs involved, inability of a robot to deal with hard tissue and other minor factors (such as robot bulk) limited the applications.^{14–17} In 2016, Turri-Zanoni et al described a multiportal endonasal-transoral approach for management of ethmoid-maxillary lesions invading the lower parapharyngeal space. Two years later, Deganello et al presented a multiportal combined approach based on transfacial or transoral maxillectomy associated with endoscopic endonasal surgery, to deal with tumours extending posteriorly into the pterygopalatine fossa, infratemporal fossa and upper parapharyngeal space.^{18,19} These two reports set the scene for the transnasal/transoral multiportal approaches that inform our maxillary pull-through method. Our approach greatly expands the possibilities of endoscopic surgery. Uniquely and importantly, we perform type VIa maxillary resection without the need for any skin incision. This greatly enhances healing, reduces the hospital stay and allows rapid introduction of adjuvant therapy for oncological patients. The association of endoscopic surgery with transoral resection makes it possible to perform *en-bloc*

resection of the hard palate and septum, with inclusion of the medial wall of the maxilla. Such a resection was traditionally possible only via a transfacial approach such as lateral rhinotomy. These approaches yield unsatisfactory aesthetic results, and slow healing may also be seen because of infection or the presence of a systemic disease such as diabetes.²⁰ Our maxillary pull-through method does not require dissection of any noble anatomical structure. The only risky step is total or subtotal ethmoidectomy, if needed, where cerebrospinal fluid (CSF) leakage is possible. However, any fistula in this area is easy to repair because the CSF pressure is low at the anterior skull base. Clean and neat dissection requires minimisation of bleeding. Thus, it is important to perform dissection in the dorsal-ventral and lateral-medial directions, beginning with sphenovomerine suture (SVS) detachment; this prevents optical clouding by runoff blood. Importantly, our maxillary pull-through technique allows for *en-bloc* resection. Although this is not an absolute requirement in terms of surgical radicality, it is always desirable when managing a malignant tumour.

Reconstruction of the hard palate defect is possible via primary closure using preserved palatal mucosa. If a complete hard palate defect is present such that the tissue must be removed, closure can be achieved using a pedicled temporalis muscle flap or simply an obturator; free flaps can also be employed. The choice of reconstruction method, of which there are many, must be informed by patient age and comorbidities, the types of defective tissues and according to whether there is any functional damage. Our procedure promotes communication between the nose and mouth, which is required for restoration of a diaphragm without dynamic function. This means that the complexity of the defect, in terms of the tissues involved, becomes less important; reconstruction based only on soft tissues is as effective as reconstruction involving complex flaps that include bone components. The reconstruction must always be discussed with the patient, and the surgeon must always clarify whether there is any possibility of morbidity of a free or pedicled flap, or of aesthetic deficits at the donor site.

Our maxillary pull-through approach can be used only when a lesion meets the following criteria: maxillary involvement is limited to the hard palate; surgical radicality can be achieved with preservation of alveolar ridge integrity; and the tumour does not infiltrate the periorbit, skin, frontal sinus, brain, pterygopalatine fossa, infratemporal fossa or parapharyngeal space. For tumours that do not satisfy these criteria, we highly recommend the approaches of Turri-Zanoni and Deganello^{18,19}; these are better for controlling lateral and posterior tumour extensions. As a final point, one of our four patients had an undifferentiated SNUC. This patient underwent surgery followed by radiation therapy in 2018. The indications for these treatments were discussed at that time by our tumour board, with reference to the current literature.²¹ The best option was considered to be surgery followed by radiation therapy. However, given the seminal work of Amit et al,²² the patient would have undergone induction chemotherapy followed by surgery if treated today. Nevertheless, the patient is FOD.

Conclusions

We encountered no complications in our series; all patients recovered rapidly. Our maxillary pull-through technique is smooth, reproducible and free from complications; the only drawback is the steep learning curve of endoscopic surgery. Thus, our technique is a valuable new surgical procedure for benign and malignant pathologies of the nasal septum that involve the hard palate. Although endoscopic ‘demolition’ is not associated with any particular risk, endoscopic skills that can be acquired only via the steep learning curve are essential; not all surgeons can employ the technique.

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ORCID iDs

Danilo Di Giorgio  <https://orcid.org/0000-0002-5756-219X>

Marco Della Monaca  <https://orcid.org/0000-0001-6235-9754>

Supplemental Material

Supplemental material for this article is available online.

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