Eur Arch Otorhinolaryngol (2013) 270:1473–1479
DOI 10.1007/s00405-012-2187-0

HEAD AND NECK

The temporo-parietal fascial flap in extended transnasal endoscopic procedures: cadaver dissection and personal clinical experience

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Received: 8 July 2012 / Accepted: 7 September 2012 / Published online: 21 September 2012

Abstract Due to progressively expanded indications of endoscopic transnasal surgery, having different reconstructive options in the armamentarium becomes of paramount importance. We herein report our experience with the use of the temporo-parietal fascial flap after extended endoscopic procedures for malignancies of the clival and nasopharyngeal regions. We focus our report on the surgical anatomy of this flap and the technique for its intranasal transposition through an infratemporal corridor. The main steps of the procedure and anatomic landmarks were highlighted, thanks to previous cadaver dissection. Five patients underwent an extended endoscopic resection for malignant tumors: one with persistent clival chordoma, three with recurrent nasopharyngeal carcinomas, and 1 recurrent nasopharyngeal adenoid cystic carcinoma. In all patients a temporo-parietal fascial flap was harvested to protect critical structures or irradiated denuded bone. The Mean harvesting and hospitalization time were 120 min and 5 days, respectively. No major or minor complications were observed. Whenever local flaps are not available for oncologic reasons or previous surgery, the temporo-parietal fascial flap is a safe and relatively easy option to protect the residual skull base and critical structures such as the internal carotid artery and dura of the posterior cranial fossa, after extended endoscopic resections.

Keywords Skull base · Endoscopic surgery · Flap · Nasopharyngectomy

Introduction

During the last 10 years, indications for endonasal approaches have expanded as a result of a better understanding of the anatomy from an endoscopic perspective, increasing surgical expertise, and concomitant technological advances in instrumentation and image-guided navigation systems. The possibility to perform an endoscopic resection of the anterior skull base and overlying dura with subsequent repair of the defect as described by Kassam et al. [1] has opened new possibilities in the management of sinonasal and skull base malignancies. As previously reported by our group, the use of autologous materials such as the iliotibial tract and fat tissue together with the standardized three-layer reconstruction in the repair of large anterior skull base defects has led to a decrease in the postoperative CSF leak rate to 1.6 %, without using lumbar drainage [2]. This multi-layer technique has shown to be effective for reconstruction of sellar defects after extended pituitary surgery as well [3].

However, the exclusive use of free grafts is not the ideal choice in the management of skull base defects of the middle and posterior cranial fossa, due to higher pressure of the leakage compared with the anterior defects, stronger adhesion of the dura to the bone, and the absence of regular bony boundaries that do not allow a precise multilayer reconstruction. Even when there is a need to protect critical structures such as the internal carotid artery (ICA) or to

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avoid radionecrosis because of previous treatment or scheduled adjuvant radiotherapy (RT), free grafts are not the ideal choice. In these cases the use of pedicled flaps may guarantee an adequate amount of well-vascularized tissue, which is crucial for the success of the procedure. In the vast majority of cases, the Hadad flap [4], pedicled on the septal branch of the sphenopalatine artery, fulfills these needs. Nevertheless, whenever the patient has been previously submitted to posterior septal resection, wide sphenoidotomy, extended ethmoidectomy, or if the tumor is invading on both sides the anterior wall of the sphenoid sinus, the blood supply of this flap can be compromised. To address these situations, other pedicled flaps have been developed namely inferior turbinate flap, [5], the middle turbinate flap [6], the palatal island flap [7–9], endoscopic modified pericranial flap [10], and the temporo-parietal fascial flap (TPFF) [11].

The aim of this report is to define the surgical anatomy of the TPFF and its harvesting technique with special focus on its infratemporal transposition after expanded endoscopic procedures, based on cadaver dissection. Furthermore, clinical findings of 5 patients submitted to an extended endoscopic transnasal procedure with TPFF transposition are also included.

Patients and methods

Anatomic study

Dissection and infratemporal transposition of TPFF was performed on both sides in one injected fresh head at the Department of Systematic Anatomy, Medical University of Wien. Images obtained from the endoscopic dissection of the infratemporal fossa were adopted in the "Surgical technique" section of the paper in order to provide the readers with clear details of this phase of the operation.

Case series

A retrospective review of the medical chart records of five patients who underwent extended endoscopic transnasal surgery with TPFF use was performed.

Clival chordoma

(Case 1) A 77-year-old female, submitted in our department to an expanded endoscopic procedure for a large clival chordoma 3 years before, was lost to follow-up and came to our attention for persistent nasal obstruction, hearing loss and recurrent bilateral otitis. During the first procedure, the resection was interrupted due to intraoperative heart failure and the patient had refused postoperative RT. A large submucosal mass at the level of the posterior nasopharyngeal wall, in contact with the soft palate and occluding both Eustachian tubes, was detected during endoscopic examination. Magnetic resonance imaging (MRI) of the paranasal sinuses and skull base showed a large clival lesion compatible with persistent chordoma (Fig. 1). Due to the patient's age, comorbidities, previous clinical history, and the extension of the disease observed by MRI, surgical resection was scheduled for purely palliative purposes to improve nasal obstruction, to avoid recurrent bilateral otitis, and to prevent brainstem compression. Treatment planning

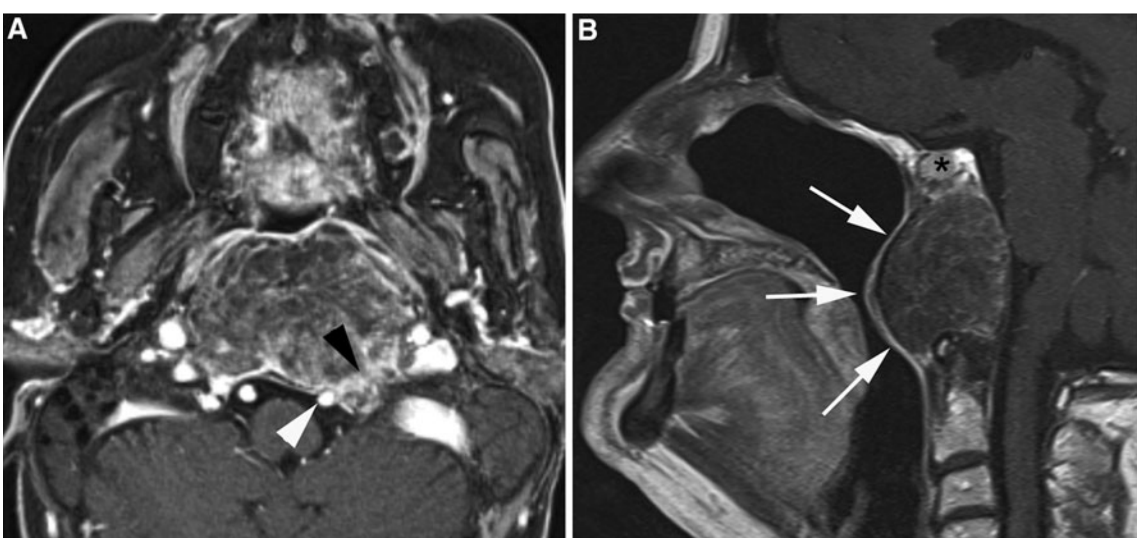

Fig. 1 Chordoma of the clivus. Post contrast T1 sequences on axial (**a**) and sagittal (**b**) plane. The clivus is completely replaced by a solid mass abutting the prepontine cistern, invading the jugular foramen on the left side (*black arrowhead*) and in contact with the vertebral artery (*white arrowhead*). The hypophysis is uninvolved. Note the intact mucosal layer covering the anterior surface of the lesion (*arrows*)

Table 1 Clinical information and treatment details of patients affected by nasopharyngeal carcinoma

Case	Gender	Age	Histology	Previous staging	Previous treatment	Staging	Last treatment	TTD positioning	Status (months after last treatment)
2	F	36	NC (WHO type-1)	cT2N1M0	CHT-RT 3 years before (Taxotere-Cysplatinum-5-Fluorouracyle: 3 cycles; 68 Gy) Brachytherapy 1 year before (20 Gy)	yrpT3N0M0	NER type-3 + TPFF	unilateral	DOD (6 months)
3	M	60	NC (WHO type-1)	cT2N0M0	RT 1 year before (68 Gy)	yrpT3N0M0	NER type-3 + TPFF	bilateral	DOD (4 months)
4	M	35	NC (WHO type-2)	cT3N3M0	CHT-RT 2 years before (Cysplatinum: continuos infusion; 70 Gy)	yrpT1N1M0	-NER type-3 + TPFF + left type-3 MRND -After 5 months right type-3 MRND for contralateral nodal relapse	unilateral	NED (12 months)

NC nasopharyngeal carcinoma *ACC* adenoid cystic carcinoma *ER* endoscopic resection *CHT* chemotherapy *RT* radiotherapy *TPFF* temporoparietal fascial flap *NER* nasopharyngeal endoscopic resection *MRND* modified radical neck dissection *TTD* trans timpanic drainage *DOD* dead of disease *NED* no evidence of disease

would be completed by adjuvant RT. For these reasons, surgical reconstruction of the skull base by pedicled TPFF was planned in order to protect both ICAs, the dura of the posterior cranial fossa and the residual skull base. Nasoseptal and other local flaps were not available due to previous surgery (Fig. 1). The endoscopic procedure was performed with the help of a navigation system and ultrasonic curette (Sonopet Omni Surgical System; Stryker, Kalamazoo, MI).

Nasopharyngeal carcinoma

(Case 2–4) Clinical findings and treatment details of three cases of recurrent nasopharyngeal carcinoma are summarized in Table 1. In all cases a type 3 nasopharyngeal endoscopic resection (NER) [12] followed by covering of the exposed skull base with TPFF was scheduled. In all these cases nasoseptal flap was not available for many reasons: in two cases the tumor involved the sphenoidal rostrum or the pterygopalatine fossa (Fig. 2) not allowing safe harvesting of this flap; in all three cases, the vascular supply of the nasoseptal flap could be compromised by previous RT; moreover, the preservation of the septal branch of the spenopalatine artery could be tricky and unsafe during a transpterygoidal approach to the Eustachian tube.

Resection of the third posterior of the nasal septum together with the sphenoid rostrum was performed to visualize the entire nasopharyngeal cavity. Laterally, the nasopharyngeal wall was uni- or bilaterally resected in relation to the extent of the tumor, through a transpterygoidal approach to include the cartilaginous portion(s) of the Eustachian tube(s) and peritubal soft tissues. The resection was superiorly extended to the anterior wall and the floor of the sphenoid sinus, and inferiorly to the level of the atlas. In one case (Table 1: case 2) the resection was extended to the ipsilateral pterygo-palatine fossa (Fig. 2). Surgical margins were examined with frozen sections and were negative in all cases. A permanent transtympanic ventilation tube was uni- or bilaterally positioned in all cases to prevent impairment of middle ear ventilation.

Nasopharyngeal adenoid cystic carcinoma

(Case 5) A 64-year-old male suspected to be affected by recurrent nasopharyngeal adenoid cystic carcinoma (ACC) treated 8 years before by an endoscopic resection and adjuvant RT (64 Gy) was referred to our department. The lesion was originally staged pT3N0M0. The MRI performed showed a 1.5 cm nodular lesion located at the base of the residual left pterygoid root along the residual vidian canal and focally eroding the petrous apex suspicious for recurrence. Under general anesthesia, with the aid of a navigation system, a biopsy of the lesion was obtained, which was found to be positive for ACC at frozen sections. A left type 3 NER with TPFF transposition was performed. Other local flaps were not feasible due to previous treatments. The last MRI, performed 12 months after surgery,

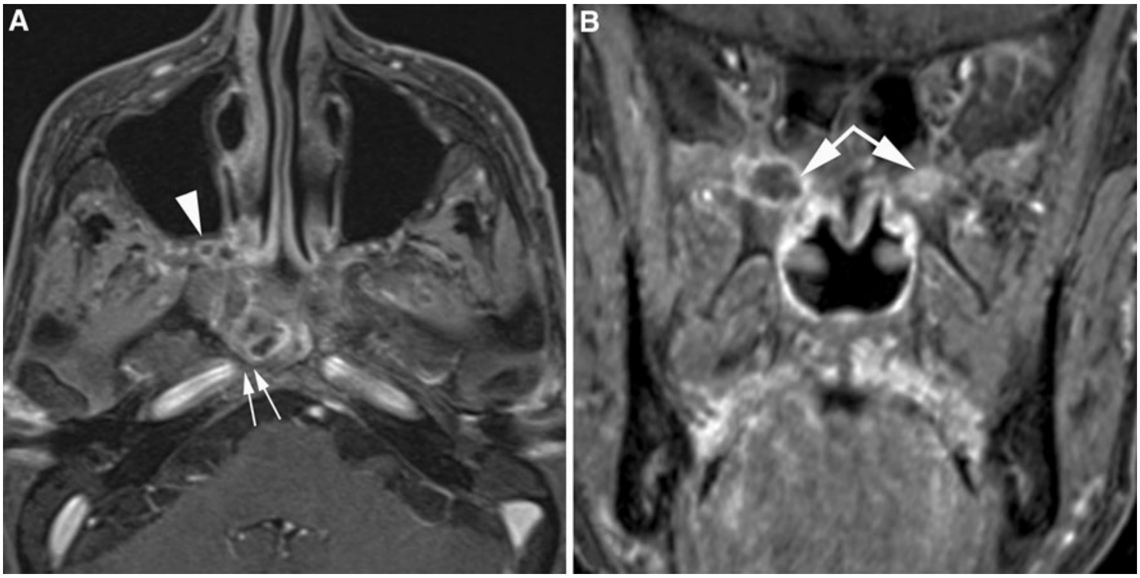

Fig. 2 Recurrent nasopharyngeal carcinoma. Post-contrast fat suppressed T1 sequences on axial (**a**) and coronal (**b**) planes. Submucosal recurrent tumor is seen at the central skull base, invading the sphenoid bone. The tumor infiltrates the right pterygopalatine fossa (*arrowhead*). Both vidian canals (*converging arrows*) are widened and display abnormal signal, and on the left the tumor extends posteriorly to the anterior foramen lacerum without invading the petrous apex (*small arrows*)

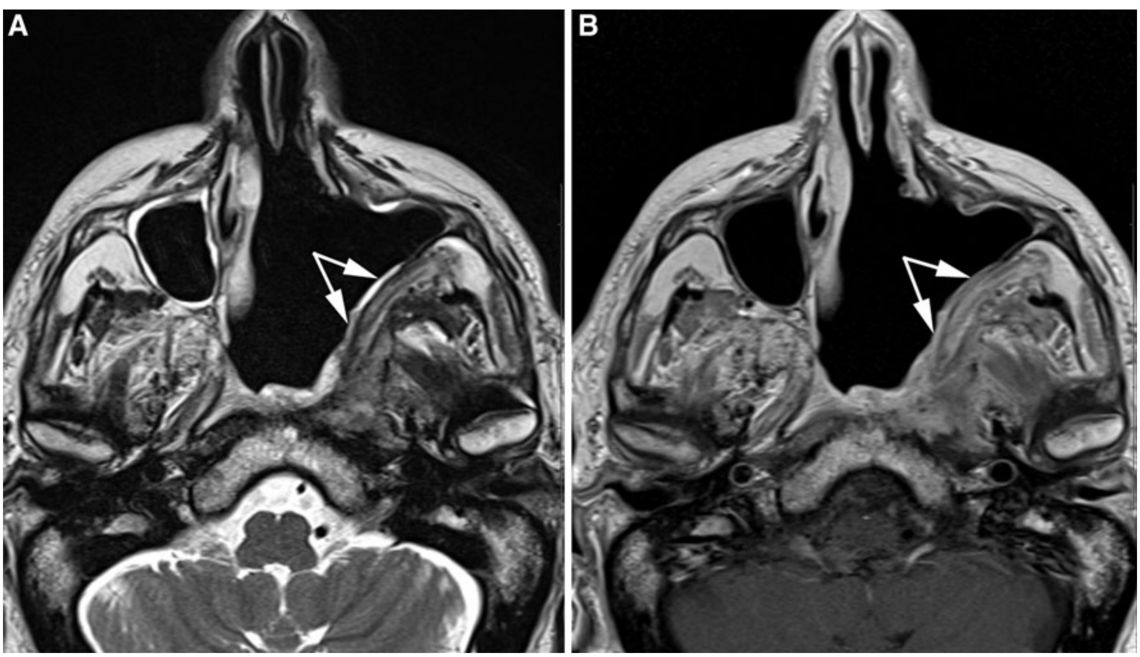

Fig. 3 T2 (**a**) and contrast enhanced T1 (**b**) sections on axial plane. The pedicled flap is seen, below the mucosal surface, rotated to reach the skull base defect at the level of the left pterygoid root

showed no evidence of recurrence. The TPFF resurfacing the nasopharyngeal cavity was clearly visible (Fig. 3).

TPFF: surgical technique

The pterygopalatine and infratemporal fossae had already been exposed at the end of endoscopic resection by performing middle antrostomy, removal of middle turbinate and posterior wall of the maxillary sinus on the affected side.

A hemicoronal incision was made among hair follicles (Fig. 4a). In the lower part of the incision, the superficial temporal artery, terminal branch of the external carotid artery, and its comitant veins were identified, carefully isolated, and preserved. The thickness of TPFF was tailored

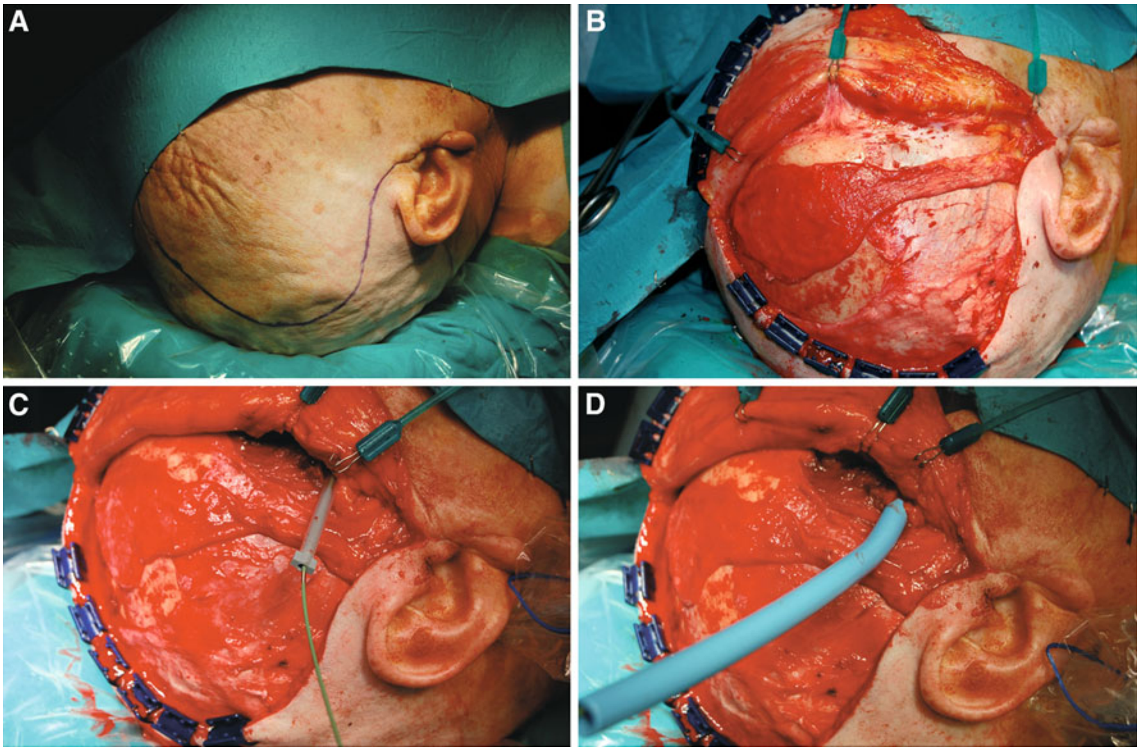

Fig. 4 External approach. **a** coronal skin incision; **b** flap harvesting; **c** guide wire positioning through the infratemporal corridor; **d** dilatation of the infratemporal corridor for subsequent flap transposition

according to the site and characteristics of the defect. The harvested flap can be limited to the superficial temporal fascia and pericranium, or can include the galea in its distal portion, or even incorporate the subcutaneous tissue of the scalp. The flap was finally demarcated and mobilized down to its pedicle (Fig. 4b). The deep temporal fascia was then incised along the free edge of the zygomatic arch and 1 cm from the free edge of the orbital process of the zygomatic bone to preserve the frontal branch of the facial nerve. The coronoid process was identified by sliding a finger along the anterior border of the temporalis muscle. In this way an infratemporal corridor for the transposition of the flap was obtained, connecting the temporal, infratemporal, pterygopalatine and nasal fossa.

The fat of the infratemporal fossa, endoscopically visible in the superolateral corner of the transmaxillary window, was progressively and gently removed. The proximal insertion of the temporal muscle over the coronoid process was clearly visible and easily identified by moving the mandible from outside; lateral to this structure the medial surface of the masseter muscle was also identified (Fig. 5). Using a Ciaglia percutaneous tracheostomy set (Cook Percutaneous Tracheostomy Introducer set, Cook Critical Care, Bloomington, IN, USA), the guide wire was inserted through the atraumatic tube positioned into the infratemporal corridor (Fig. 4c, 6a,b), which was subsequently

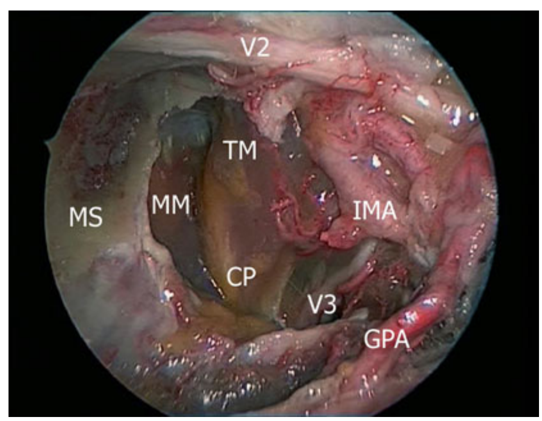

Fig. 5 Right nasal fossa, 0 degree telescope: cadaver dissection of the pterygopalatine and infratemporal fossa through a transmaxillary approach with resection of the entire medial and posterior walls of the maxillary sinus. *MS*: maxillary sinus, *MM*: masseter muscle, *TM*: temporal muscle, *CP*: coronoid process, *V2*: maxillary nerve, *V3*: mandibular nerve, *MA*: maxillary artery, *GPA*: great palatal artery

enlarged with the dilatators provided (Fig. 4d). Once a tunnel, wide enough to not compress the vascular pedicle of the flap was obtained, the guide wire was fixed to the distal portion of the TPFF by a stitch and the flap was finally pulled into the nasal cavity (Fig. 6c). During this procedure attention was paid to avoid any torsion of the

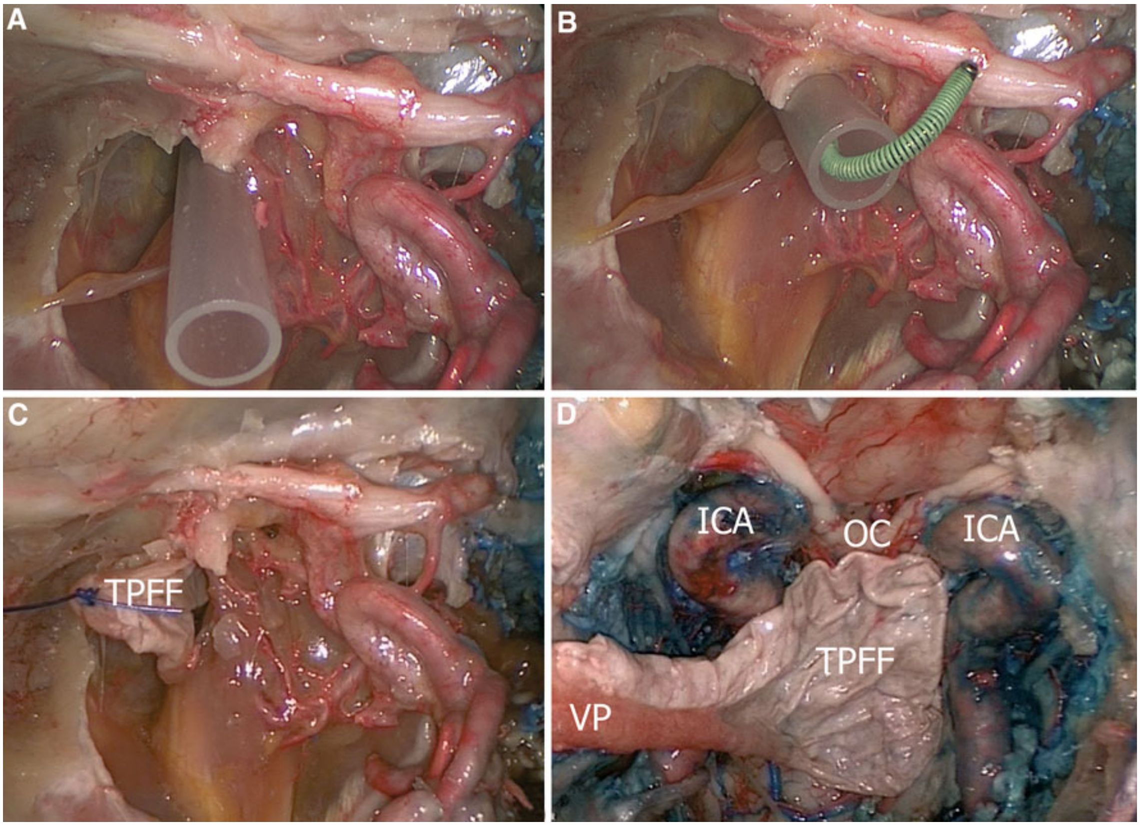

Fig. 6 Right nasal fossa, 0 degree telescope: cadaveric dissection. **a** Transnasal endoscopic view: positioning of the atraumatic tube through the infratemporal fossa; **b** The guide wire is subsequently inserted; **c** The flap previously fixed to the guide wire by a stitch is pulled into the nasal cavity (TPFF: temporo-parietal fascial flap); **d** The flap is positioned at the level of the clival defect (*ICA*: Internal carotid artery; *OC*: Optic chiasm; *TPFF*: Temporoparietal fascial flap; *VP*: vascular pedicle)

vascular pedicle. The flap was positioned over the defect (Fig. 6d), and fixed with a few drops of fibrin glue.

Results

The harvesting time ranged from 90 to 150 min (mean 120), and was strictly related to the learning curve. A haircut for flap harvesting was never performed in female patients. No postoperative major or minor postoperative complications were observed. Nasal packing was removed 2 days after the surgical procedure, without significant bleeding in all the cases. The mean hospitalization time was 5 days (4–6). Transient or persistent alopecia on flap harvesting site did not occur in any patient, and because the incision was made among hair follicles no visible scars developed, with the exception of a bald patient. Regular irrigations of the nasal cavity were prescribed to decrease crust formation and to promote the healing process. At present, two patients (cases 4 and 5), are alive with no evidence of loco-regional relapse at 12 and 17 months after surgery, respectively. Three patients (cases 1–3) died for local persistent disease at 8, 6, and 4 months after treatment, respectively.

Discussion

The goal of reconstructive techniques after extended endoscopic procedures is to safely separate the cranial cavity from the sinonasal tract and to protect critical structures that are exposed during the surgical procedure. As reported by other authors [6], the choice of technique needs to be tailored according to the size and site of the defect, the history of previous endonasal surgery or RT, patient comorbidities, and the need for postoperative adjuvant treatment. The successful outcome of CSF leak repair by autologous free grafts through endoscopic endonasal procedures has been widely recognized. [2, 3]. In our experience, the use of free grafts is a safe procedure even in patients with large defects of the anterior cranial fossa [13, 14]. In this specific surgical setting, the use of a vascularized flap is not crucial to reduce the rate of postoperative complications, even in patients treated for persistent or recurrent lesions after RT [2]. Moreover, in the large majority of our patients, the transnasal craniectomy had been performed for primary malignant lesion of the sinonasal tract. In these cases, for evident oncologic reasons, most of the local pedicled flaps are not available.

When an endoscopic extended resection of the clivus or nasopharynx is performed, serious complications and sequelae may occur. CSF-leak from the posterior cranial fossa, extensive dural exposure, radionecrosis of the residual skull base, or ICA exposure with subsequent risk of arterial infection and potential blow out, must be considered. When all other options are exhausted, TPFF provides abundant healthy and well-vascularized tissue to protect critical areas at the end of the endoscopic procedure. The advantages of this flap are predictable vascular anatomy, good arch of rotation, length of the vascular pedicle, and rich vascularization with subsequent quick healing even in unfavorable conditions such as in previously irradiated patients. Its dimension and thickness can be tailored according to specific necessities, taking into account that the risk of transient or persistent alopecia increases in relation to flap thickness. Moreover, its pliability allows covering extended skull base defects with complex multiplanar surfaces.

This flap is characterized by a remarkable intrinsic versatility. It can be adopted for the reconstruction of different anatomical sites including the oral cavity [15], auricle [16], and skull base after open procedures [17]. Moreover, some authors have reported its use as a microvascular free flap [18].

During its harvesting and intranasal positioning there is no need to perform lateral canthotomy to separate the temporalis muscle from the lateral orbital wall, as previously reported [11]. Care must be taken to avoid accidental twisting of the vascular pedicle and to not damage the frontal branch of the facial nerve.

In conclusion, in patients with extended defects of the posterior cranial fossa with exposure of dura, previously irradiated bone or ICA, in whom other pedicled flaps are not available, TPFF is a safe and relatively easy option, with acceptable lengthening of the operating time, low morbidity at the donor site, negligible complication rate, and no influence on hospitalization time. More studies on larger series are needed to confirm its value in reducing sequelae such as osteoradionecrosis or recurrent infection of the residual skull base.

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