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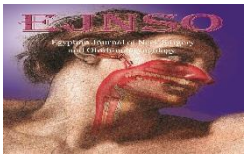

Reconstruction of a large anterior skull base defect with a multilayer graft augmented by a vascularized flap: A technical note

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Abstract:

Skull base reconstruction of the anterior cranial fossa after the excision of large sinonasal or skull base tumors is still a challenge. The local flaps may be not available or insufficient to seal the whole defect. Harvesting regional flaps or free flap is a time-consuming procedure that may increase postoperative morbidity. We report a technique for reconstruction of anterior skull base using autologous grafts covered by free mucosal graft that is augmented by vascularized flaps in 2 cases. A 51 years old female patient with olfactory neuroblastoma underwent endonasal endoscopic resection followed by multilayer reconstruction using 3 layers of fascia lata sandwiched between a mucosal graft from above and double middle turbinate flaps from below. The second case was 48 years old male patient with non-intestinal type adenocarcinoma invading the anterior skull base. The resection of the tumor was done endoscopically and 3 layers of fascia lata were utilized and covered by a mucosal graft from above and the nasoseptal flap from below for reconstruction. No postoperative CSF leak was reported in either case. The graft augmented flap technique was effective that prevent postoperative morbidity.

Keywords: Reconstruction, skull base, tumors, adenocarcinoma.

Introduction:

Endoscopic resection of intracranial basal lesions, and sino-nasal neoplasms invading the cranial base, through a nasal corridor, has been reported as an effective and safe method. [1,2] Post-excision defects reconstruction is still a challenge; however, there are many advanced techniques of cranial base repair. A vascularized flap addition to the repair was reported to greatly reduce postoperative CSF leaks risk. [3, 4]Sometimes, especially when resecting the sino-nasal malignancies, the availability of a sufficient vascularized nasal flap to seal the defect completely is doubtful. Regional or free flaps utilization was found to be effective in cranial base reconstruction in selected cases. [5-7] However, harvesting such flaps requires separate incisions, and increases both the operative time and postoperative morbidity. We described a technique for a large anterior cranial base defects reconstruction using autologous mucosal graft augmented with a vascular-based flap.

Material and methods:

Two patients were presented with nasal mass invading anterior cranial fossa and operated at Alexandria University and

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Assiut University Hospital, Egypt, between 2018 and 2021. Both patients underwent endoscopic craniofacial resection and reconstruction with multilayer technique using Fat graft, Fascia Lata, and mucosal graft with a vascularized nasal flap side to side.

Case 1:

A female patient 51 years old presented to the outpatient otolaryngology clinics at Alexandria University Hospital complaining of recurrent bilateral epistaxis associated with bilateral nasal obstruction of insidious onset and progressive course throughout 8 months duration. Nasal endoscopy revealed a fleshy nasal mass eroding the nasal septum posteriorly and occupying the upper part of the nasal cavity and only the lower part of the middle turbinate could be seen. Contrast-enhanced multi-slice computed tomography (MSCT) of the nose and paranasal sinuses (PNS) revealed a large nasal mass, measuring 4.7 x 4.4 x 4.4 cm, eroding the nasal septum, ethmoidal air cells, cribriform plate, ethmoid roof, and both lamina papyracea. Gadolinium-enhanced Magnetic resonance imaging (MRI) of the brain, nose, and PNS revealed an intracranial intradural extension of the mass. **(Figure1)**

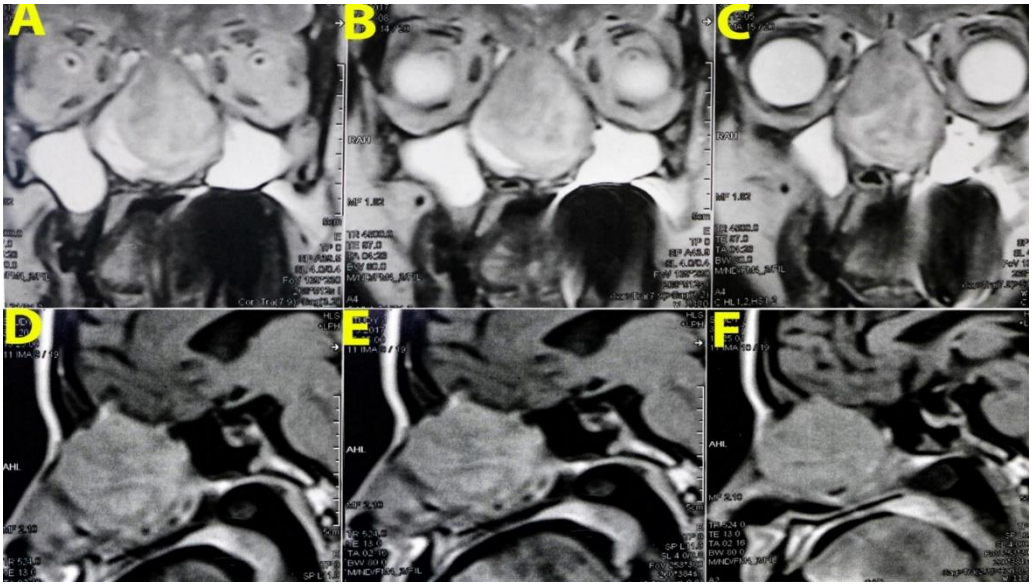

Figure 1 MRI nose and PNS with brain cuts. A, B &C) T2 weighted images coronal cuts showing heterogenous huge nasal mass destroying nasal septum and occupy the whole nasal cavity with intracranial extension. D, E&F) T1 weighted images sagittal cuts depicting the intracranial extension of the mass

Preoperative biopsy was taken under local anesthesia revealed esthesioneuroblastoma confirmed with immunohistochemistry. The preoperative planning was to resect the mass under general anesthesia (UGA) through an endonasal endoscopic craniofacial approach and to reconstruct the resultant defect using multi-layer autologous grafts (fascia lata+fat+ any available local mucosal graft).

Operative technique:

After induction of the general anesthesia, the orotracheal tube was inserted. After decongestion of the nasal cavity using xylometazoline hydrochloride 0.1%,

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debulking of the nasal mass was performed leaving the part attached to the anterior skull base (ASB). Exposure of the whole ventral sull base by removing the whole posterior septum with the upper portion of the middle turbinate and bilateral sphenoidotomy. Then Draf III frontal sinusotomy was done. Exposure of the anterior and posterior ethmoidal arteries then they were cauterized and transected . After that the tumor was completely excised with the cribriform palte of he ethmoid bone, crista galli and the involved dura creating a large anterior skull base (ASB) dural defect (about 4.8 cm^2). After confirmation that the remnants of both middle turbinates were tumor-free by frozen section biopsy, we decided to partially cover the lower part of the defect with both middle turbinates based on the middle turbinate artery a branch of the sphenopalatine artery (SPA) and we removed the mucosa on the lateral side of both turbinates using the microdebrider. After reconstruction of the whole defect with multilayers of fascia lata. **(Figure2)**

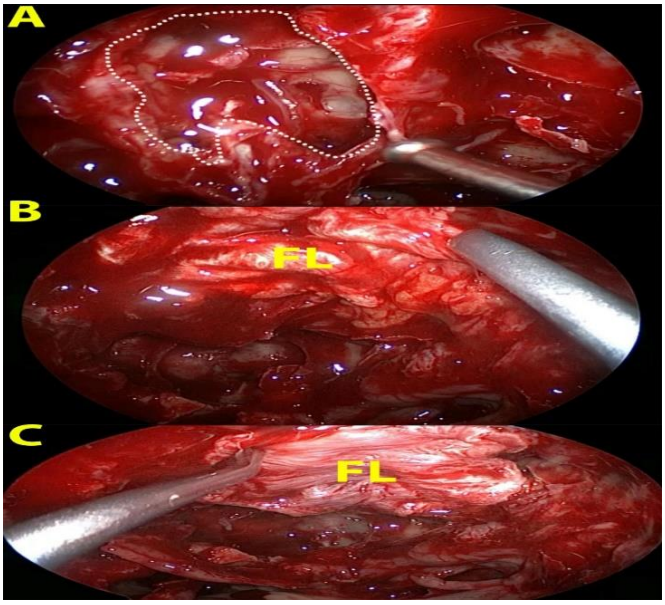

Figure 2 large dural defects after endoscopic craniofacial resection. A) The anterior cranial base dura was excised with the gyrus rectus exposed (dotted line). B) Fascia lata was applied under the bony edges (underlay technique) C) The second layer of the fascia lata was applied over the bony edges of the defect. FL:fascia lata

The upper part of the repair was covered by a free mucosal graft harvested from the nasal floor. Then we applied both middle turbinate flaps (MTF) over the lower part of the repair. **(Figure3)** The reconstruction was supported by an intranasal 30 -mL Foleys catheter -which was inflated till the desired support was achieved- and nasal sponge. The nasal packs and the catheter were removed after 5 days. Postoperatively the patient was neurologically intact with no CSF leak through her one-year follow-up.

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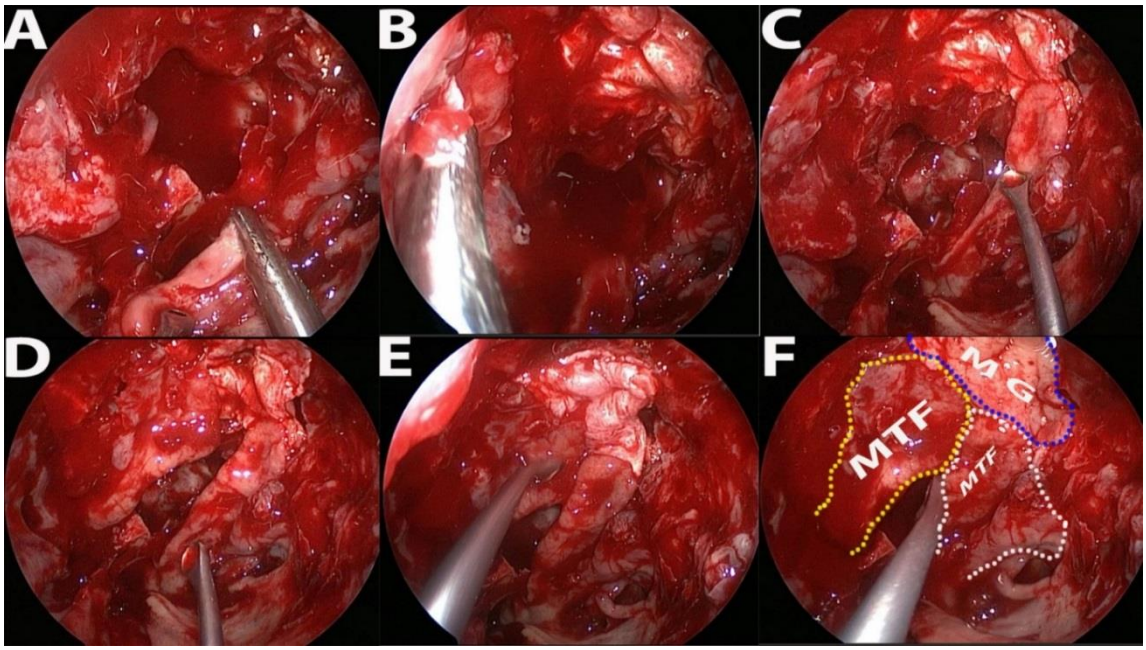

Figure 3 Elevation of both MTFs based on SPA. A&B) removal of MT medial mucosa by the microdebrider. C) placing the right MT flap over the defect. D&E) reflecting the left MT flap over the defect. F) covering the upper part of exposed fascia lata by Mucosal graft, right middle turbinate flap: yellow dotted line left middle turbinate flap white dotted line mucosal graft blue dotted line. MTF: middle turbinate flap MG: mucosal graft

Case 2:

A 48 years old male presented to the outpatient clinics, Otolaryngology Department, Assuit University Hospital with a recurrent nasal mass known to be low-grade nonintestinal adenocarcinoma. He underwent a previous endoscopic nasal surgery outside our center for tumor resection one year ago without available data. The patient had a history of 28 sessions of radiotherapy. On examination, a nasal mass was found filling the upper posterior part of the nasal cavity and eroding the posterosuperior part of the nasal septum. Multislice CT showed soft tissue opacity occupying the upper part of the nasal cavity eroding the upper posterior part of the nasal septum and ethmoid air cells extending into the frontal sinus with scalloping of both nasal bones. The anterior skull base was dehiscent. Gadolinium-enhanced Magnetic resonance imaging (MRI) of the brain, nose, and PNS revealed thickening of the anterior fossa dura with a small intradural extension of the previously described mass. **(Figure 4)** We decided to resect the tumor through an expanded endonasal approach. The preoperative planning to reconstruct the ASB defect by multilayer autologous grafts.

Surgical technique:

After excision of the tumor together with the upper posterior part of the septum, both middle turbinates, cribriform plate, and Crista Galli, we had a large bony ASB defect (about 4 cm^2). We confirmed that the posterosuperior margin of the remaining part of the septum was tumor-free by the frozen section biopsy.

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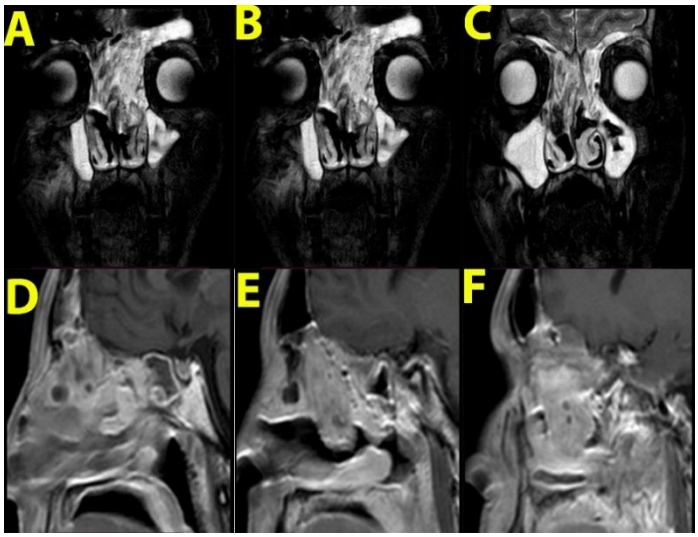

Figure 4 MRI nose and PNS with brain cuts. A, B &C) T2 weighted images coronal cuts showing heterogenous nasal mass occupy the upper nasal cavity and the frontal sinus. D, E&F) T1 weighted images sagittal cuts depicting the intraracial extension of the mass.

Using the trans nasal doppler (Mizuho 20 MHz Doppler system, Mizuho America, Beverly, USA) we confirmed the vascular supply of the remaining nasal septum, the nasoseptal flap was harvested in the classic technique. After multi-layer reconstruction of the defect using fat and fascia lata. the upper part of the reconstruction-free mucosal graft and the nasoseptal flap covered only the lower part of the repair. **(Figure 5)** The reconstruction was supported by a nasal sponge which was removed after 5 days. Postoperatively, there was no CSF leak during his one-year follow-up period. But the patient experienced prolonged nasal crustations during that year.

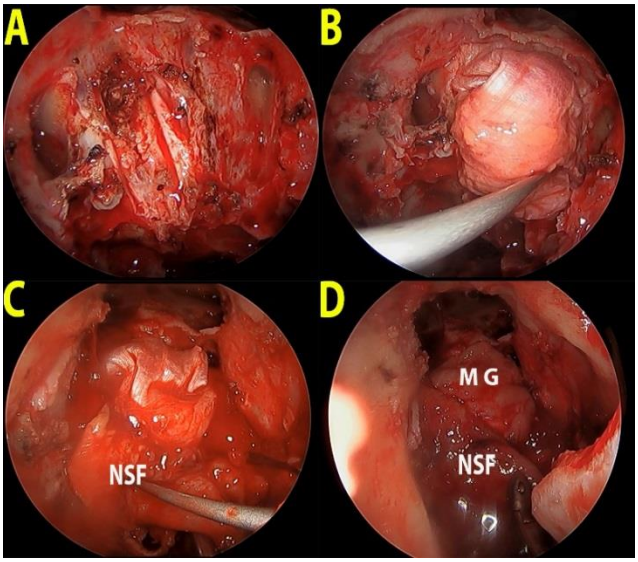

Figure 5 the reconstruction of a large ASB defect. A) Large bony defect result after excision of adenocarcinoma. B) Reconstruction of the defect with multilayers of fascia lata C) the NSF was not enough to cover the whole defect. D) A free mucosal graft was applied and augmented with the flap. NSF: nasoseptal flap MG: mucosal graft

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Discussion:

Skull base reconstruction is the most vital step after excising sino-nasal tumors eroding skull base or intracranial tumor requiring basal craniectomy. The main goal of the skull base reconstruction is to provide complete watertight separation between intracranial contents and nasal cavity to avoid CSF leak, pneumocephalus, and intracranial infection. Other goals of reconstruction are preservation of different ocular and neurovascular structures, and dead spaces obliteration. [8] The primary outcome of skull base reconstruction is to reduce the incidence of CSF leak which is the only measure to reflect the success of this procedure. [3, 4]

Extended approaches create large defects with increased incidence of CSF leak postoperative up to 30-40%. The introduction of vascularized flap reduced the incidence of CSF leak to 6.7-11.5 %. [3, 4] Sigler et al reported defects ≥ 2 cm^2 as one of the modifying factors that require vascularized flap whatever the type of intraoperative CSF leak. [9]

Most of the sinonasal tumors that invade the anterior cranial fossa are malignant and there is a need for combined radiotherapy. The addition of a vascularized flap is indicated in patients with a history of previous or expected need for radiotherapy whatever the size of the defect. [9]

After extirpation of extensive sinonasal tumors that have an intracranial extension, the vascular supply of the local nasal flaps may be disrupted, or the surface area of the remaining possible flap may be insufficient to cover the whole defect. The alternative solution is to harvest regional flaps-though separate incisions- as pericranial flaps or utilizing free flaps which are more time-consuming, increase morbidity, and maybe technically difficult.

The plan of skull base reconstruction may be specifically modified for individual patients as dural defects are rarely the same. A certain clinical situation may direct the surgeon to exclude a certain common repair method and adopt a less commonly used one. [10]

In this work, we described reconstruction of the large anterior skull base defects with high flow CSF leaks using a mucosal graft augmented by vascularized flaps, double middle turbinate flaps in one case, and the nasoseptal flap in the other case. We had large anterior skull base defects that could not be covered completely with the remaining parts of the available vascularized flaps. So we used multi-layer repair of the defect using fat, fascia lata. Then a mucosal graft covering the upper part of the repair and then we added the harvested flaps to cover the lower part of the repair. In our opinion, this would provide the vascularization of the repair thus reducing the postoperative healing time. The advantage of this technique is that we harvested the flap utilizing the same approach without adding any external incision which may increase the postoperative morbidity. It is also less time-consuming. In addition, we preserved the regional as well the free flaps if the reconstruction failed, especially the patients who had a history of or were expected to have radiotherapy. In a cadaveric study, the authors described their technique to increase the length of the nasoseptal flap by suturing a mucosal graft to the flap thus adding 3 cm to its length to cover as far as the anterior wall of the frontal sinus. [11] Different studies described the utilization of the double flap technique to increase the surface area of the coverage area of the flap. [12, 13]

During the follow-up of both cases for 1 year, the patients did not have any CSF leak however one patient showed prolonged nasal crustation. Except for anosmia patients were neurologically intact.

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Conclusion:

The graft augmented flap technique is a safe, successful technique for the reconstruction of large anterior skull base defects to prevent the postoperative CSF leak, intracranial infection, pneumocephalus and radionecrosis. This technique is a good option if pure endonasal endoscopic resection of anterior skull base tumor is planned with preservation of the regional as well as the distant free flaps if delayed reconstruction failure is anticipated when post-operative radiotherapy is expected.

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