Endoscopic Repair of Skull Base Defects Using Free Tissue Transfer: A Case Series

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Introduction

Open approaches to the ventral skull base have been increasingly replaced by endoscopic endonasal approaches due to lower associated morbidity. Expanded endoscopic techniques provide access to the vast majority of the ventral skull base, allowing for safe treatment of pathology that would have previously required an open approach. Likewise, these techniques can allow for the endoscopic reconstruction of skull base defects not previously amenable to minimally invasive repair. The use of free tissue transfer for the repair of large or otherwise challenging ventral skull base defects is well described in the literature, but traditionally requires access through an open approach such as a bifrontal or orbitozygomatic craniotomy. An endoscopic approach for inset may allow for precise flap placement while minimizing the morbidity associated with an open approach.

Objectives

1) **Describe the surgical technique for endoscopic placement of a free tissue flap via either a transmaxillary or retropharyngeal approach for repair of complex ventral skull base defects.**

2) **Analyze our institutional outcomes in a series of consecutive patients undergoing endoscopic repair of ventral skull base defects using free tissue transfer.**

Methods

A retrospective review of the electronic medical record was performed of 9 consecutive patients with ventral skull base defects who presented to a tertiary care academic medical center between 2016 and 2024 and underwent endoscopic surgical repair with a free flap. Multiple variables were collected including patient demographics, surgical and treatment history including proximate need for flap, defect location, intraoperative technique, and post-operative complications including CSF leak and flap failure.

Results

Table 1. Patient Demographics and Surgical Information

Patient #	Pathology	Defect Location	Prior Chemo/Radiation?	Prior Repair?	Flap Type	Corridor	Complications
1	ORN with osteomyelitis	Clivus and nasopharynx	Yes, CXRT	No	ALT	Retropharyngeal	None
2	ORN with osteomyelitis	Cribriform	Yes, CXRT	Yes, 2x	ALT	Transmaxillary	None
3	ORN with CSF leak	Cribriform	Yes, XRT	Yes	ALT	Transmaxillary	None
4	Giant adenoma	Sella/Tuberculum/Planum	No	Yes	ALT	Transmaxillary	Late CSF leak
5	ORN with herniation	Cribriform	Yes, proton and avastin	Yes	ALT	Transmaxillary	None
6	ORN with CSF leak	Clivus	Yes, proton	Yes	ALT	Retropharyngeal	None
7	CSF leak	Sella/Tuberculum/Planum	No	Yes	ALT	Transmaxillary	None
8	CSF leak	Clivus	Yes, XRT	Yes, multiple	ALT	Retropharyngeal	None
9	ORN with osteomyelitis	Cribriform	Yes, proton 2x	Yes	ALT	Transmaxillary	None

Surgical Technique

Flap Harvest:
In all cases, concurrent with the endoscopic resection, a second team raised a muscle ALT free flap in standard fashion. In brief, an incision is made down to the rectus femoris, and the rectus and vastus lateralis are separated to reveal the lateral circumflex pedicle running on the vastus intermedius into the vastus lateralis. An appropriately sized strip of vastus lateralis is harvested, and the pedicle is traced proximally to ensure adequate length for reconstruction.

Transmaxillary Approach:
A complete medial maxillectomy is performed endoscopically. A sublabial incision is then made and after subperiosteal dissection an anterior maxillary antrostomy is created using a drill and then widened using Kerrison rongeurs. The inferior orbital nerve is protected and the medial buttress is preserved if possible to support the pyriform aperture but can be removed if necessary to tunnel the flap. A second incision is made in the neck or overlying the mandible and the facial vessels are identified and preserved. The flap is placed into the nasal cavity via the sublabial incision, and the pedicle is tunneled via the sublabial incision through the buccal space and lateral to the mandible to the facial vessels.

Retropharyngeal Approach:
A neck incision is made, facial vessels are identified and preserved, and blunt dissection is performed superiorly posterior to the pharynx until a connection is made into the nasopharyngeal defect. This tunnel is dilated with progressively larger Hegar uterine dilators until it is of sufficient size for the flap to fit through, and a 1 inch penrose drain is passed through the tunnel. The flap is then passed from the neck into the penrose and pulled into the nasopharynx, with the the pedicle remaining in the neck adjacent to the facial vessels.

Flap Inset:
Following initial reconstruction using alloderm and gelfoam, the flap is positioned endoscopically against the skull base completely covering the defect. Care must be taken to ensure that the flap is flush with no dead space between it and the skull base. The flap is secured into place using nasopore absorbable packing followed by multiple merocels which in turn is supported by a nasal trumpet. As the flap is not otherwise secured to the skull base, it is critical that the packing is left in place long enough to allow for the flap to heal down. A CT brain is obtained immediately postoperatively to ensure proper positioning of the flap. As the flap has no external paddle, it is monitored using either a Cook implantable doppler or with an external doppler stitch depending on the accessibility of the pedicle.

Figure 1. Flap Harvest

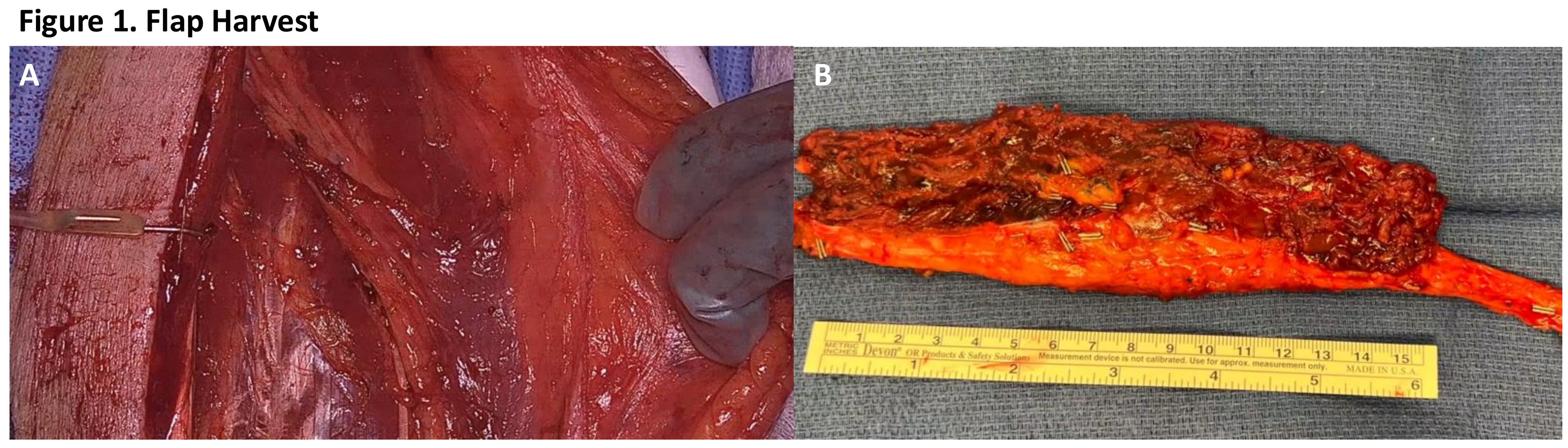

Fig. 1: Vastus lateralis muscle with lateral circumflex pedicle A) in situ and B) after flap harvest.

Figure 2. Transmaxillary Approach

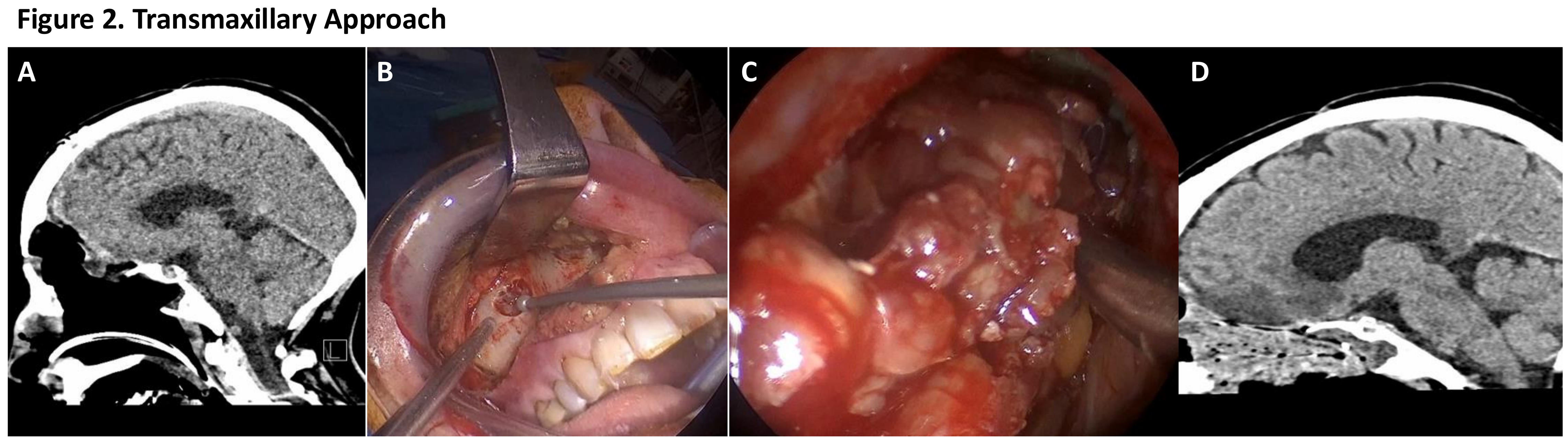

Fig. 2: A) Sagittal view of pre-operative CT scan showing anterior fossa defect. B) Drilling anterior maxillectomy via sublabial approach to create tunnel for flap inset. C) Endoscopic inset of flap after placement through transmaxillary corridor. D) Sagittal view of post-operative CT scan showing flap in place along anterior fossa.

Figure 3. Retropharyngeal Approach

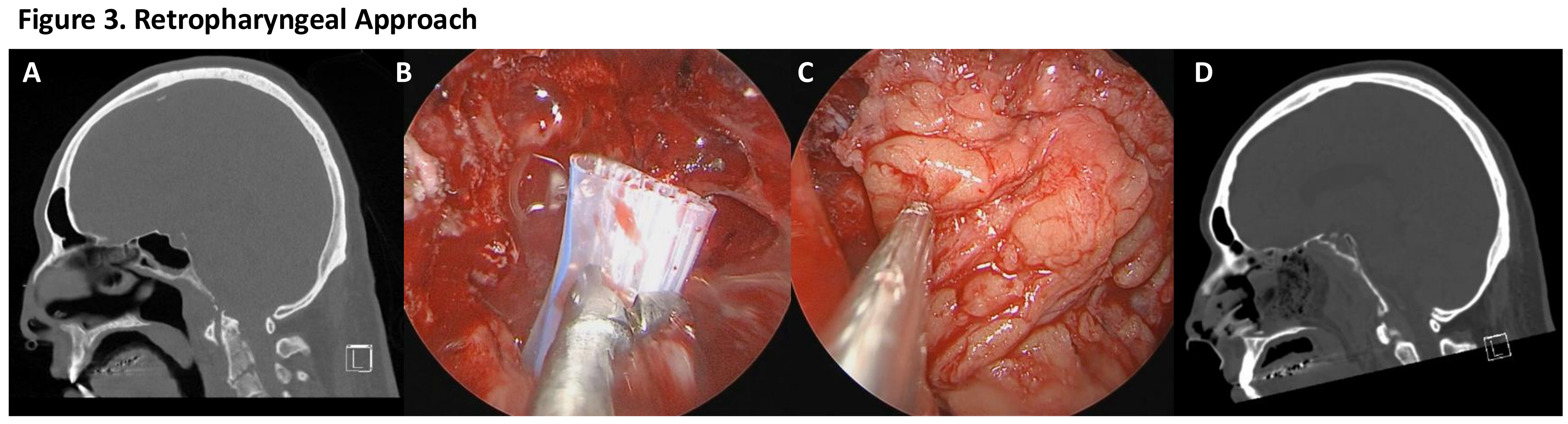

Fig. 3: A) Sagittal view of pre-operative CT scan showing clival defect. B) Pulling penrose through retropharynx to create tunnel for flap inset. C) Endoscopic inset of flap after placement through retropharyngeal corridor. D) Sagittal view of post-operative CT scan showing flap in place along clivus.

Conclusion

This case series – to our knowledge the largest to date - presents the repair of challenging anterior skull base defects in 9 patients using free flaps delivered and inset via a minimally invasive endoscopic approach.

In all cases a vastus lateralis muscle only anterolateral thigh free flap was utilized for the reconstruction. This flap has several advantages for an endoscopic approach including sufficient bulk and vascularity to allow for reconstruction of large defects with unhealthy tissue while having enough pliability to be tunneled to the inset site and to conform to the 3D anatomy of the skull base when packed into place. The flap also has sufficient pedicle length to allow for anastomosis to the facial vessels, particularly in the transmaxillary approach in which the facial vessels can be identified and anastomosed to above the level of the mandible. While not necessary in our series, vein grafting may be utilized in patients with prior free flap surgery or an otherwise vessel depleted neck. Other possible options for flaps include a muscle only latissimus or a de-epithelialized or adipofascial radial forearm. The former offers a significant volume of thin, pliable muscle with acceptable pedicle length but a more cumbersome simultaneous harvest compared to an ALT, while the latter provides significantly greater pedicle length but much less tissue volume, making it less suitable for large defects.

Choice of corridor for tunneling the flap into the nasal cavity primarily depends on the location of the skull base defect. The transmaxillary approach is versatile, allowing placement all along the ventral skull base including superiorly to the planum and cribriform. The retropharyngeal approach is most appropriate for defects of the inferior ventral skull base, as the flap enters the nasal cavity posteroinferiorly in ideal position to cover nasopharyngeal and clival defects, but the distance the pedicle must traverse limits superior reach. In this series both corridors were found to be effective, allowing the flap to be placed appropriately in all cases with acceptable pedicle geometry and ability to perform microvascular anastomoses. There were no flap failures or recurrent CSF leaks in the immediate post operative period, with 8 of 9 patients having successful long term repair. As such, endoscopic placement does not appear to compromise flap or repair viability when used in appropriate patients.

Overall, endoscopic free flap placement for skull base repair allows surgeons to leverage the advantages of free tissue transfer such as large tissue volume, customization, and the ability to bring healthy, vascularized tissue into a radiated field while avoiding the morbidity associated with open approaches to the skull base. Further studies are needed to continue to optimize delivery corridors and inset technique.