

Single-layer repair of massive anterior skull base defects without nasoseptal flap

Frederick Yoo, MD¹; Marilene B. Wang, MD¹; Marvin Bergsneider, MD²; Jeffrey D. Suh, MD¹

¹Department of Head and Neck Surgery, ²Department of Neurosurgery
David Geffen School of Medicine at UCLA, Los Angeles, California

Abstract

Objectives: Endoscopic techniques for resection of anterior skull base (ASB) tumors have advanced in recent years, allowing for complete excision of larger tumors via endoscopic endonasal approach. Bilateral skull base defects are most commonly repaired using a multi-layered reconstruction followed by unilateral or bilateral nasoseptal flaps. Use of a single-layer closure of large ASB defects with an acellular dermal allograft (Alloderm) has been described previously in literature with a high success rate, but this technique has yet to gain widespread use. We report our experience in a series of five patients with esthesioneuroblastomas who underwent reconstruction of large, bilateral ASB defects using a single-layer intradural graft, without nasoseptal flaps. We also compared the results of Alloderm or collagen matrix xenograft (Duramatrix) use as the graft biomaterial.

Study design: Retrospective case series.

Methods: The medical records of five patients with single-layer closure of large, bilateral ASB defects treated at a tertiary academic medical center were reviewed.

Results: Two patients were reconstructed with Alloderm and three with Duramatrix, with successful single-layer closure and postoperative external beam radiation therapy. The patients with Alloderm graft both had prolonged postoperative crusting for over 12 months, with symptomatic infections requiring multiple courses of antibiotics. Of the Duramatrix patients, both patients had complete resolution of crusting 3 months after surgery, without signs of infection.

Conclusions: Single-layer repair without nasoseptal flap is a viable method of skull base repair for large ASB defects. In this small series, repair with Duramatrix was superior with less graft crusting and infection, requiring substantially fewer debridements than patients reconstructed with Alloderm.

Introduction

Endonasal endoscopic surgical techniques have advanced greatly over the past three decades. In recent years, attention has been placed on endonasal endoscopic approaches to resection of anterior skull base tumors. These approaches have yielded comparable disease free outcomes compared to open approaches, with reduced morbidity.¹ After resection of these anterior skull base tumors, often large defects are left behind which require reconstruction to close cerebrospinal fluid (CSF) leaks and prevent other complications such as meningitis and other intracranial infections. These large skull base defects are most often reconstructed using a multi-layered approach, requiring an intradural layer, with an extradural layer with a vascularized flap, most commonly a nasoseptal pedicled flap. In 2007, Germani et al. described a single layer reconstructive approach using Alloderm, a human acellular dermis allograft, to reconstruct large anterior cranial skull base defects.² Although this approach produced excellent outcomes, single-layer skull base reconstruction is not widely in use today. In this study, we describe our experience with single-layer anterior skull base defect reconstruction. We also compare the outcomes after reconstruction with two different types of graft materials, including Alloderm and Duramatrix, a bovine purified type 1 collagen matrix xenograft.

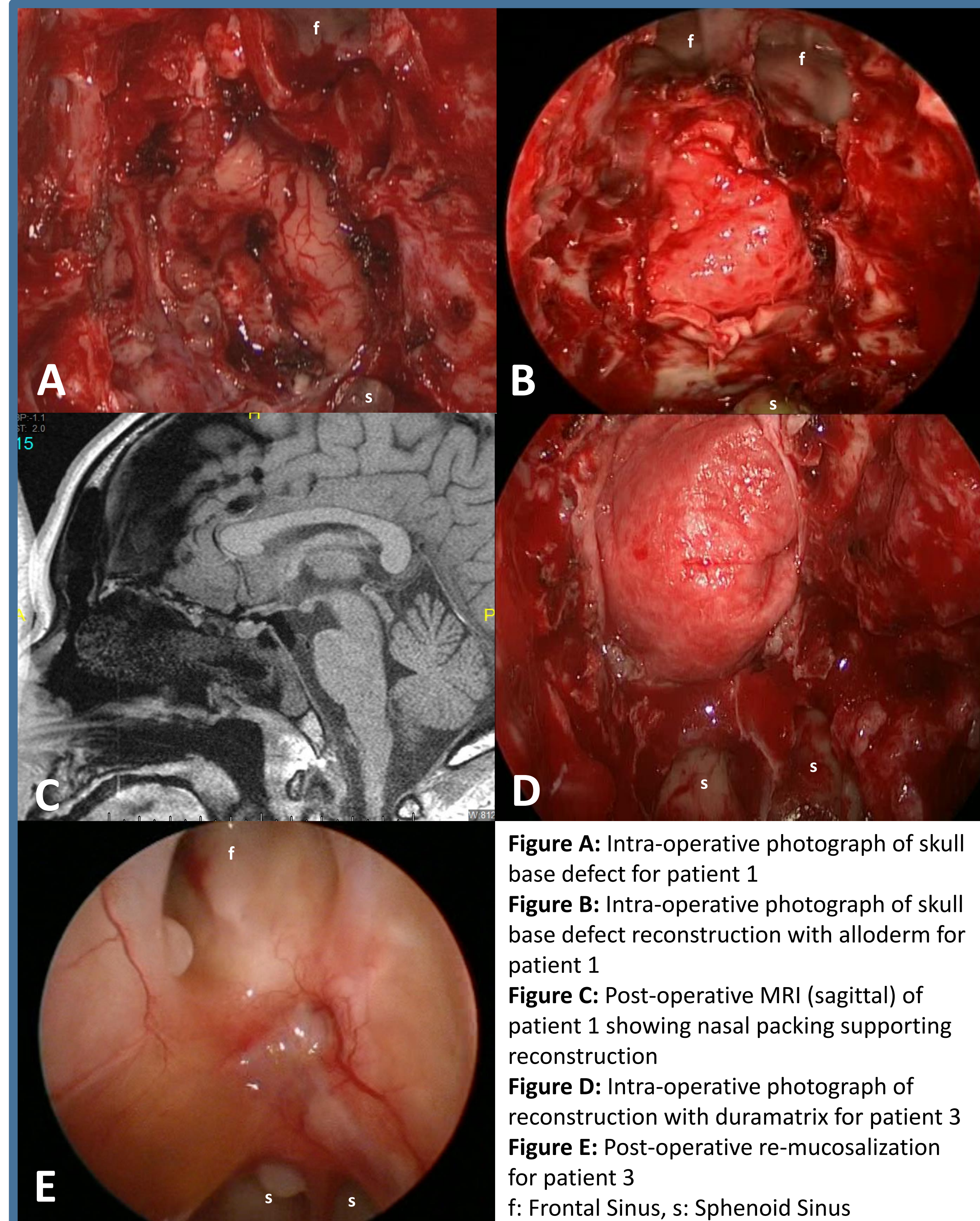


Figure A: Intra-operative photograph of skull base defect for patient 1
Figure B: Intra-operative photograph of skull base defect reconstruction with alloderm for patient 1
Figure C: Post-operative MRI (sagittal) of patient 1 showing nasal packing supporting reconstruction
Figure D: Intra-operative photograph of reconstruction with duramatrix for patient 3
Figure E: Post-operative re-mucosalization for patient 3
f: Frontal Sinus, s: Sphenoid Sinus

Results

A total of five patients underwent transnasal endoscopic resection of an anterior skull base tumor. All five patients' pathology was esthesioneuroblastoma. Two patients underwent reconstruction with a single layer of Alloderm, while three patients were reconstructed with a single layer of Duramatrix. The single layer grafts were placed intradurally for each patient. The grafts were then secured using fibrin glue. The patients were followed up for a range of 4-36 months. All patients have completed postoperative external beam radiation therapy. None of these patients had CSF leak at any point during their follow up period. Patients 1 and 2 were reconstructed with Alloderm and patients 3-5 with Duramatrix. The Alloderm group required long term continuous debridements in follow up of up to 20 months, whereas the Duramatrix group required only up to 3 months of continuous debridement. The Duramatrix group also had fewer operative site infections and reduced time to re-mucosalization in those patients who had achieved total re-mucosalization of the graft site.

Patient Number	Path	Recon type	Size of defect	Time of continuous debridement	# of post-operative infections	Time to re-mucosalize.
1	Esthesio	Alloderm	1.75 x 3.5 cm	15 months	3	18 months
2	Esthesio	Alloderm	2.3 x 2.5 cm	20 months	9	20 months
3	Esthesio	Duramatrix	4.0 x 3.0 cm	1 month	1	10 months
4	Esthesio	Duramatrix	2.5 x 2.0 cm	2 months	2	TBD
5	Esthesio	Duramatrix	1.5 x 3.0 cm	3 months	1	TBD

Table 1. Characteristics of patients with single layer anterior skull base defect repair.

Discussion

In our series, we confirm the findings of Germani et al. in applying a single-layered approach to reconstruction of large skull base defects with successful outcomes. In that study, the authors defined large dural defects as being larger than 2.0 cm in diameter and reported a graft success rate of 100% in 12 patients with defects larger than 2.0 cm in diameter.² Our study included five patients with defects larger than 2.0 cm in diameter, with a defect average area of 6.975 cm² (5.0-12.0 cm² range), with a 100% graft success rate. Patient 3 in our series required the use of abdominal fat in order to fill the resultant dead space after excision of a large esthesioneuroblastoma. The fat was placed in order to allow for enough inferiorly directed pressure on the graft during reconstruction and active CSF leak was still noted after placement of the abdominal fat. It was not considered as part of the reconstruction of the skull base defect.

We compared the outcomes of using two different graft materials, Alloderm and Duramatrix. The first two patients in the series were reconstructed using Alloderm, however, due to extensive, long-term postoperative crusting and recurrent infection, Duramatrix was used for the latter three patients. All five patients were without CSF leak on follow up of up to 36 months, even after adjuvant external beam radiation therapy. The results in Table 1 show that patients reconstructed with Duramatrix had a shorter time period after surgery of continuous debridement, reduced number of postoperative infections and reduced time to remucosalization. The reason for this discrepancy is unknown but further study with more patients is warranted to truly investigate this difference. This may be related to inherent differences in structure of the graft materials.

In literature, recommendations for reconstruction of large anterior skull base defects are often multi-layered, with utilization of a vascularized flap.^{1,3-4} In the past, a rigid layer was recommended as well to prevent sagging from the defect site, but the need for a rigid support has not been substantiated in literature.^{3,5} A systematic review performed in 2012 by Harvey et al. revealed a 6.7% leak rate for reconstructions using a vascularized flap, as opposed to non-vascularized free graft reconstructions with a leak rate of 15.6%, and this study has been the basis for many of the recommendations for use of a vascularized flap in large skull base defects.⁶ The vascularized nasoseptal flap has become the work horse of skull base surgery since its introduction by Hasad and Bassagasteguy in 2006.⁷ Other vascularized flaps have been introduced which have shown similar success in skull base reconstruction.^{3,8-9} With the findings from this study and from the previous study by Germani et al., we believe that a single-layer reconstruction should be also considered for reconstruction of some large anterior skull base defects, especially those with adequate bony ledges to support the graft.

The advantages of a single-layer closure using biomaterials is that it eliminates donor site morbidity and complications, it can be customized to any size defect and it is readily available for use.

Conclusions

With our series, we confirm the findings of previous authors showing that single layer reconstruction of large anterior skull base defects can be a potential effective option for endoscopic skull base surgeons. All five patients who had single layer reconstruction had no evidence of CSF leak after surgery in the follow up period. We also compared outcomes of two different biomaterials, Alloderm and Duramatrix, and found Duramatrix reconstruction led to decreased postoperative crusting, fewer surgical site infections and reduced number of debridements required following surgery.

Corresponding author

Jeffrey D. Suh, MD
10833 Le Conte Ave CHS 62-132
Los Angeles, CA 90095
jeffsuh@mednet.ucla.edu

References

- Zuniga MG, Turner JH, and Chandra RK. Updates in anterior skull base reconstruction. *Curr Opin Otolaryngol Head Neck Surg.* 2016;24(1):75-82.
- Germani RM, Viviero R, Herzallah IR, et al. Endoscopic reconstruction of large anterior skull base defects using acellular dermal allograft. *Am J Rhinol.* 2007;21(5):615-8.
- Chin D and Harvey RJ. Endoscopic Reconstruction of Frontal, Cribriform and Ethmoid Skull Base Defects. *Adv Otorhinolaryngol.* 2013;74:104-118.
- Patel, MR, Stadler ME, Snyderman CH, et al. How to Choose? Endoscopic Skull Base Reconstructive Options and Limitations. *Skull Base.* 2010;20:397-404.
- Eloy JA, Shukla PA, Choudhry OJ, et al. Assessment of Frontal Lobe Sagging After Endoscopic Endonasal Transcribriform Resection of Anterior Skull Base Tumors: Is Rigid Structural Reconstruction of the Cranial Base Defect Necessary?. *Laryngoscope.* 2012;122:2652-7.
- Harvey RJ, Parmar P, Sacks R, et al. Endoscopic skull base reconstruction of large dural defects: a systematic review of published evidence. *Laryngoscope.* 2012 Feb;122(2):452-9.
- Hadad G, Bassagasteguy L, Carrau RL, et al. A novel reconstructive technique after endoscopic expanded endonasal approaches: vascular pedicle nasoseptal flap. *Laryngoscope.* 2006;116:1882-6.
- Patel MR, Taylor RJ, Hackman TG, et al. Beyond the Nasoseptal Flap: Outcomes and Pearls With Secondary Flaps in Endoscopic Endonasal Skull Base Reconstruction. *Laryngoscope.* 2014;846-52.
- Zanation AM, Snyderman CH, Carrau RL, et al. Minimally Invasive Endoscopic Pericranial Flap: A New Method for Endonasal Skull Base Reconstruction. *Laryngoscope.* 2009;119:13-18.