

Endoscopic Endonasal Dural Reconstruction for a Cerebrospinal Fluid Leak in the Middle Cranial Fossa of a Patient with Gorham-stout Disease with Skull Base Defect

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Abstract

We report the use of endoscopic endonasal surgery for dural reconstruction following a cerebrospinal fluid leak in a 33-year-old patient with recurrent meningitis since at age of 2 years. Magnetic resonance imaging showed osteolytic changes in the left temporal and sphenoid bones, including the left pterygoid plate, a few left temporal encephaloceles, and cerebrospinal fluid-like fluid in the expanded Meckel's cave and the parapharyngeal space. After endoscopic endonasal surgery, Gorham-Stout disease was diagnosed. No recurrence of cerebrospinal fluid leakage or meningitis has been observed. Thus, endoscopic endonasal surgery might improve clinical outcomes in patients with Gorham-Stout disease and skull base defects.

Keywords: Gorham-Stout disease, cerebrospinal fluid leak, endoscopic endonasal surgery, dural reconstruction, skull base

Introduction

Gorham-Stout disease (GSD) is a rare disorder characterized by massive osteolysis, usually in a unicentric pattern in isolated bones.¹⁻¹¹⁾ It features gradual bone destruction by angiomatosis and overstimulation of osteoclasts and may advance into neighboring soft tissues. The efficacy of surgical treatment for cerebrospinal fluid (CSF) leaks in adults with GSD and skull base defects is uncertain because of the paucity of surgical reports. To our knowledge, this is the first documented use of endoscopic endonasal surgery (EES) to treat a CSF leak from a skull base lesion in an adult with GSD. Written informed consent for publication of this report and accompanying images was obtained from the patient.

Case Report

A 33-year-old woman was referred to our hospital after diagnosis of a CSF leak. She had a history of eight epi-

sodes of meningitis, starting at age of 2 years. She had no history of orthostatic or chronic headaches, and there were no neurological deficits. Magnetic resonance imaging (MRI) (Fig. 1a-i) and computed tomography (CT) (Fig. 2a-d) showed osteolytic changes in the left temporal and sphenoid bones of the middle cranial fossa, including the left pterygoid plate. Additionally, a few left temporal encephaloceles and CSF-like fluid in the expanded Meckel's cave and left parapharyngeal space were present. The osteolytic lesions were enhanced in the equilibrium phase on gadolinium-T1 weighted imaging, suggesting the possibility of lymphangioma. On MRI, radioisotope (RI) cisternoscintigraphy 2.5 h after RI injection (Fig. 2e) suggested CSF leak associated with a T2 high-intensity lesion centered in the left pterygoid plate, whereas a CSF leak site was not identified. Fiberoptic laryngoscopy did not identify a CSF leak in the nasal cavity or paranasal sinuses or discharge from the Eustachian tube or ear. Although the actual site of CSF leakage could not be confirmed, MRI showed CSF-like fluid collection in the sphenoid bone adjacent to the

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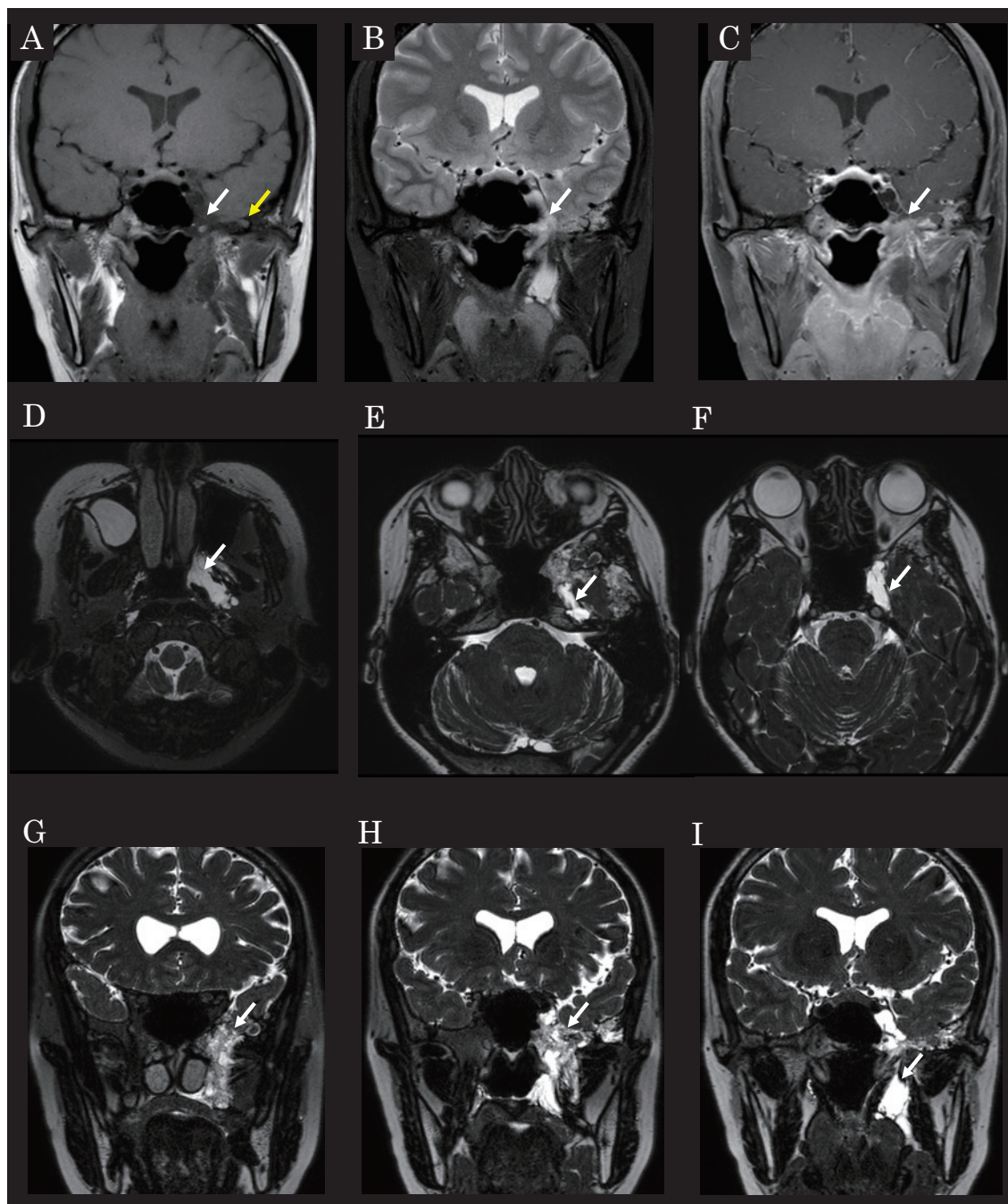


Fig. 1 Preoperative magnetic resonance imaging.

a: Coronal T1-weighted image reveals a low-signal lesion in the left temporal bone of the middle cranial fossa extending from the sphenoid bone, including the left pterygoid plate (white arrow) and a left temporal encephalocele (yellow arrow).

b: Coronal T2-weighted image shows a heterogeneous high signal lesion at the same site as a (white arrow).

c: Coronal gadolinium-T1-weighted image reveals a heterogeneous enhancement lesion at the same site as a and b (white arrow).

d-f: Axial view of the T2-weighted image-driven equilibrium radiofrequency reset pulse (T2WI-DRIVE) shows cerebrospinal fluid (CSF)-like collections in the left parapharyngeal space (d: white arrow) and a CSF-like fluid in the expanded Meckel's cave extending to the petrous apex (e, f: white arrow).

g-i: Coronal view of the T2WI-DRIVE reveals a heterogeneous high signal lesion in the left temporal bone of the middle cranial fossa and the sphenoid bone, including the left pterygoid plate (g, h: white arrow) and a CSF-like fluid in the left parapharyngeal space (i: white arrow).

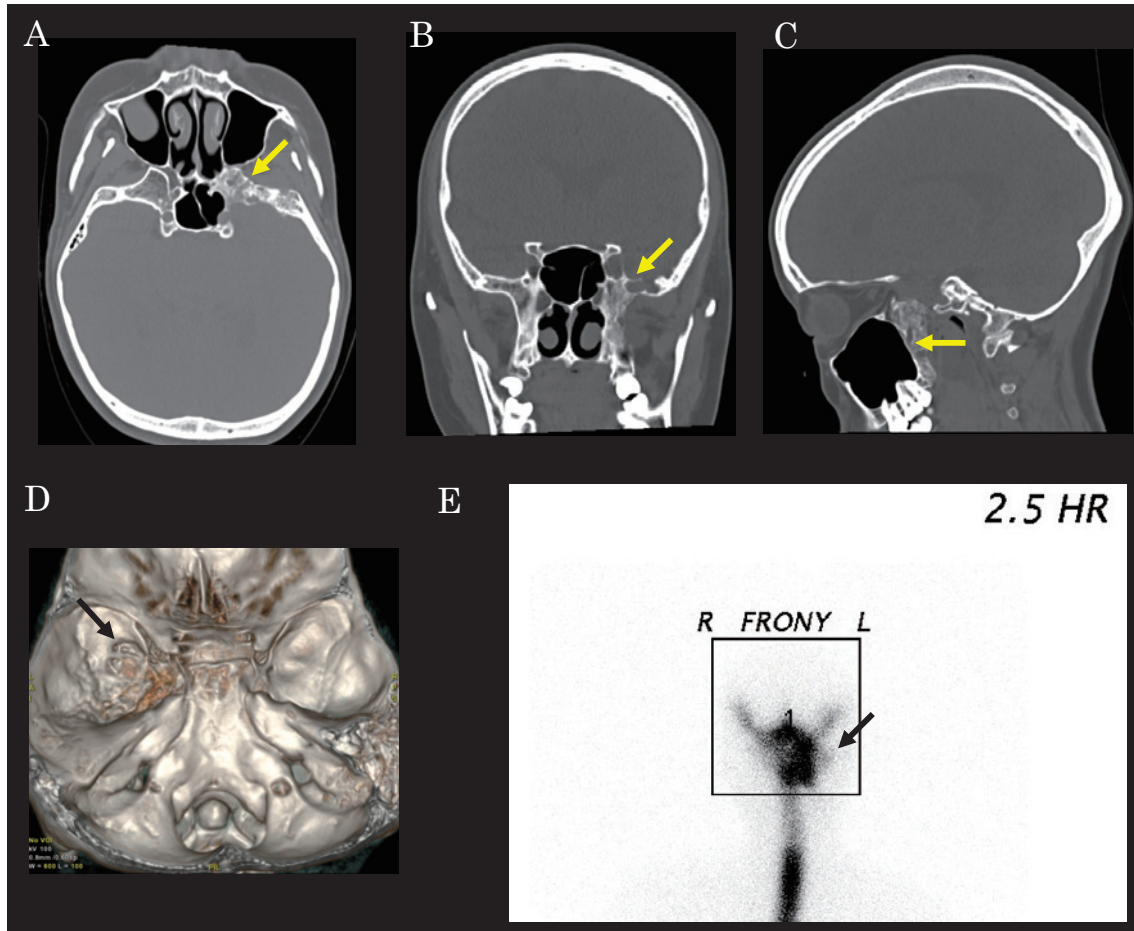


Fig. 2 Preoperative computed tomography (CT) and Radioisotope (RI) cisternoscintigraphy. a-c: Axial (a), coronal (b), and sagittal (c) CT images showing osteolytic changes in the left temporal bone of the middle cranial fossa and the sphenoid bone, including the left pterygoid plate (yellow arrow). d: Three-dimensional (3D) CT view reveals the left middle cranial base with uneven changes and skull defects (black arrow). e: Radioisotope (RI) cisternoscintigraphy 2.5 h after RI injection suggests CSF leaks (black arrow) consistent with a T2-WI DRIVE high-intensity lesion centered in the left pterygoid plate (Fig. 2a, b), whereas no apparent CSF leak site was identified.

left pterygoid plate, which was considered the site of leakage. Thus, a diagnosis of middle cranial fossa CSF leak related to GSD with skull base defect was suspected. To reconstruct the dura in the left middle cranial fossa and definitively diagnose GSD, EES was selected for the following reasons: with using EES, we could observe the entire area of possible leaking points in the sphenoid sinus, including the medial side of the Meckel's cave, the pterygoid plate, and the parapharyngeal space, where could not be observed via TCS. Furthermore, by using the mucosal flap, we could cover the entire sphenoid bone, including not only the current leak point but also new possible leaking points in the future. Additionally, EES required no brain retraction.

Surgical procedure

EES was performed via the left transsphenoid, ethmoid, and transmaxillary-ptyergoid approach using neuronaviga-

tion. A left nasoseptal flap was prepared. Following inferior turbinectomy, left medial maxillectomy, posterior ethmoidectomy, and wide sphenoidotomy were performed with preserving the sphenopalatine artery (SPA). Cranial nerve V2 was mobilized to fully expose the dura of the middle cranial fossa lateral to the internal carotid artery. While drilling the pterygoid plates extending to the hollowed-out foramen rotundum, a dark red membrane-like tissue, suggestive of lymphangioma, was exposed, taken in several small fragments with bone tissue, and submitted as a pathological specimen. The bone cavity appeared to be continuous with the anterior dural wall of Meckel's cave and the middle cranial fossa encephalocele, suggesting a possible CSF leak through this route. Thinning dura anterior to the left Meckel's cave was observed, where a mild CSF leak was noticed. This was closed using Gelfoam[®] (Pfizer, NY, USA) and fibrin glue. The fluid collection in the left parapharyngeal space was explored. Reconstruction

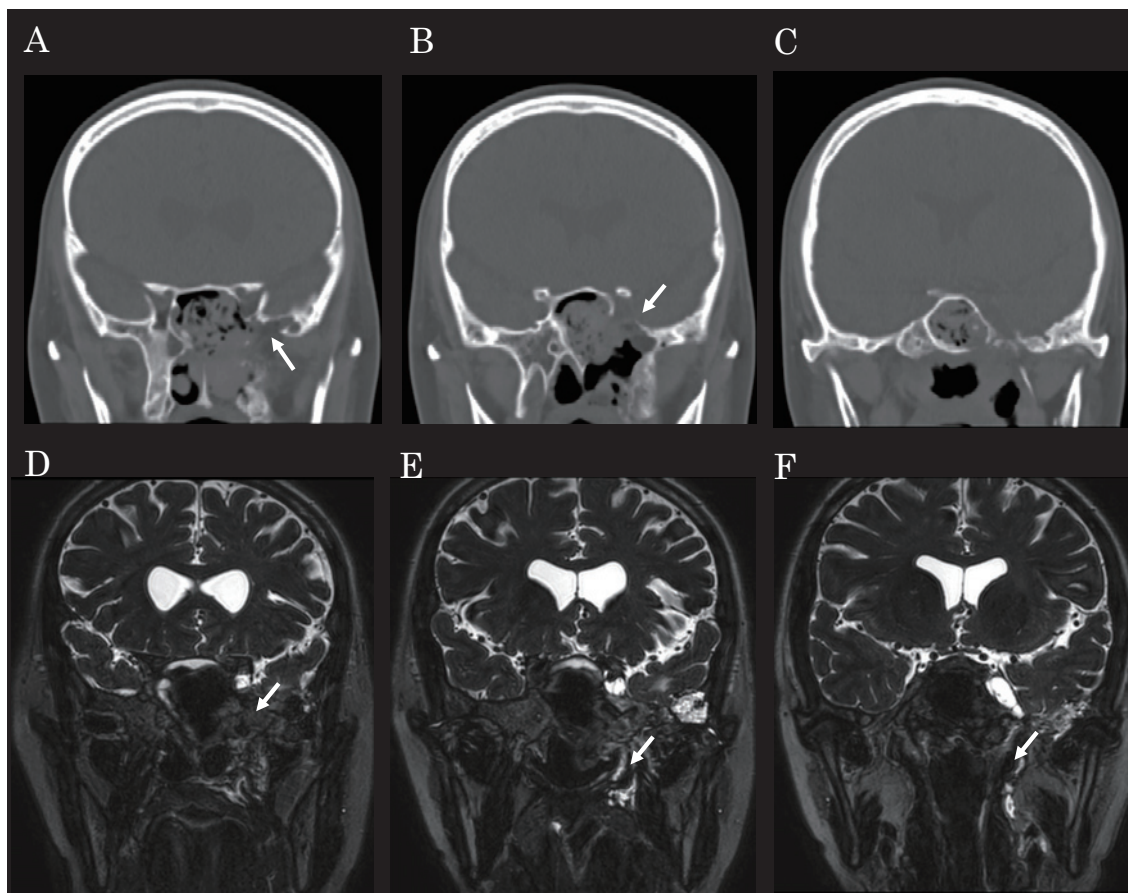


Fig. 3 Postoperative computed tomography (CT) and postoperative magnetic resonance T2-weighted imaging DRIVE. a-c: Coronal CT view showing the drilled medial and lateral pterygoid plates extending to the left temporal bone in the middle cranial fossa (white arrow) and no pneumocephalus. d-f: Coronal view of T2WI-DRIVE revealing disappearance of preoperative T2WI-DRIVE high signal (Fig. 1 g-i) consistent with the extent of bone removal (d, e) and a marked decrease in liquid-formed CSF leak-like high signal (f) on the preoperative T2-WI DRIVE in the left parapharyngeal space (white arrow).

of the thinning dura at the anterior wall of the left Meckel's cave was performed by covering it with a fascia lata flap, which was fixed with fibrin glue. The dural defect at the encephaloceles was repaired by packing with abdominal fat. Initially, we planned to use the left nasoseptal flap and prepared it by making an incision above the left nasal septum mucosa; consequently, we were able to repair with mucosal flaps of the sphenoid sinus and the left middle turbinate. Thus, the prepared left nasoseptal flap was not used and was repositioned; then, the left inferior turbinate was reconstructed (Video 1).

Postoperative course

CT (Fig. 3a-c) on postoperative day (POD) 1 showed the drilled medial and lateral pterygoid plates extending to the foramen rotundum and the left temporal bone in the middle cranial fossa. There was no pneumocephalus. MRI (Fig. 3d-f) on POD 7 revealed bone erosion removal in the middle cranial fossa. There was no high signal suggesting CSF

leak on the postoperative T2-weighted imaging-driven equilibrium radiofrequency reset pulse (T2WI-DRIVE) in the pterygoid plate and left parapharyngeal space. Otolaryngologic fibroscopy revealed no CSF rhinorrhea or nasal or paranasal sinus infection. No postoperative complications, such as neurological deficit, CSF leak, or infection, were observed. Spinal drainage and nasal packing were removed on PODs 5 and 7, respectively. The patient was discharged on POD 15 after excluding a late CSF leak. The patient attended regular outpatient follow-up appointments and achieved a score of 0 on the modified Rankin Scale after 12 months. No recurrence of CSF leak or meningitis has been noted.

The pathological diagnosis (Fig. 4) was lymphangioma, consistent with GSD. No malignant features were observed in any operative specimen.

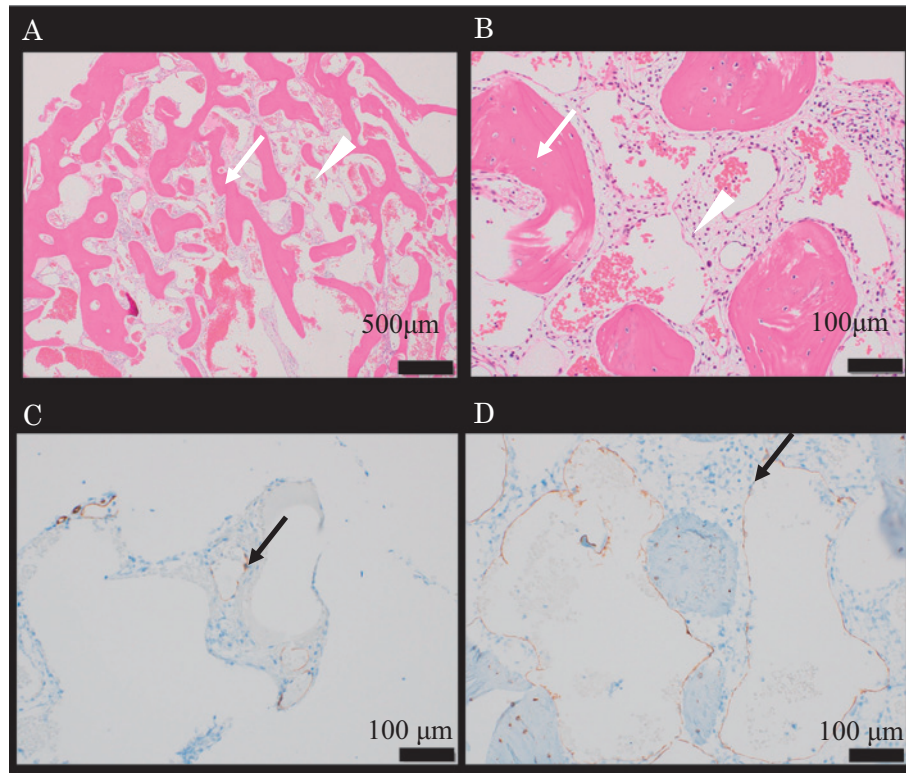


Fig. 4 Pathological findings.

a, b: The typical findings of affected bone are activated osteoclasts (white arrow) and thin-walled endothelium-lined capillaries of vascular or lymphatic origin (white arrowhead) (a: low-power field; b: high-power field; H&E stain).

c: CD35 immunostaining delineates the vascular endothelium (arrow).

d: D2-40 immunostaining is positive, as is the endothelium of the lymphatic channels (arrow).

Discussion

There are no prior reports of EES being used to treat CSF leaks in adults with GSD; however, a single pediatric case report has been reported.¹¹⁾ We report the first use of EES in dural reconstruction for CSF leakage in the middle cranial fossa of an adult with GSD.

GSD¹⁻¹¹⁾ and generalized lymphatic anomaly (GLA)^{4,8,10)} are rare and intractable diseases of unknown etiology characterized by diffuse lymphoid infiltration of systemic organs and associated with significant morbidity and mortality. GSD, also known as *vanishing bone disease*,⁵⁾ is considered related to GLA and may feature similar lesions in internal organs, including osteolytic lesions. Histopathologically, normal bone is replaced by vascular lymphatic proliferation rather than neoplastic growth.^{2,4,6-8)}

Treatment options have historically been limited, and conventional medical therapies are generally ineffective. Surgical resection is performed for local control of lesions; nevertheless, because the disease is systemic and diffuse, a cure is difficult. Depending on the lesion site, radiation therapy is occasionally used; however, it is not recommended in most pediatric cases.^{2-4,6-8,10)} For inoperable lesions, drugs, such as steroids, interferon-alpha, propra-

nolol, vincristine, bisphosphonates,¹⁾ and vitamin D,¹⁾ have been used with limited effectiveness. Emerging data suggest roles for sirolimus^{7,10)} and zoledronic acid³⁾ as treatment options for complex lymphatic anomalies.

In a retrospective study involving six patients with GSD and skull base defects,¹¹⁾ the patients were classified into nasotemporal (NT) and vertebrotemporal (VT) groups according to the anatomical location of the defects. All four NT patients had petrous defects extending anteriorly, including sphenoid, ethmoidal, and mandibular defects,¹¹⁾ as in the present case. One patient in the NT group had an osteolytic lesion that did not extend past the midline. All four patients in the NT group had CSF leaks and recurrent meningitis, as in our case, and there were no deaths. Two had epilepsy, hearing loss, and paralysis. The two VT patients had defects in the temporal bone, occipital bone, and cervical spine. There was no CSF leakage; however, both patients died because of brainstem compression. Five of six patients had a type I Chiari malformation, which was not observed in our case. In this retrospective study¹¹⁾ and in the previous reports,¹²⁻¹⁸⁾ surgery included transcranial petrosectomy or endonasal surgery for CSF leak management (the use of endoscopy is unclear) and neurosurgery for brainstem decompression; however, these surgeries

did not ensure long-term effects. Simon et al.¹¹⁾ noted that the major complications of skull base defects are CSF leakage and brainstem compression, both of which require surgical treatment that could only be performed if the disease was unstable. In our case, the CSF leak was controlled using EES. Our observation period was relatively short; hence, careful long-term follow-up is necessary.

Interestingly, in a study that systematically reviewed all published cases of GSD involving the jaw, the high rate of persistence after treatment was found to be associated only with lesions crossing the midline.²⁾ Because our case was an adult with a left-sided localized osteolytic lesion and the NT group had a relatively good prognosis in the above-mentioned retrospective study, we speculate that future progression of osteolysis may not occur. If our patient exhibits osteolysis progression in the future, complex medical treatment, including molecular-targeted drugs, might be considered.

For a cranial base reconstruction in the present case, a nasoseptal flap pedicled by the SPA would be a reliable option, and we actually prepared it. Conversely, the transmaxillary-pterygoid approach involves dissecting the ipsilateral SPA; therefore, a nasoseptal flap is generally harvested from the contralateral side. However, in our case, since a wide area of the left middle cranial fossa should be covered with a mucosal flap, it seemed more certain to use a left nasoseptal flap; thus, we initially prepared a left-sided flap. For this reason, the transmaxillary-pterygoid approach was done with preserving the SPA; this is technically demanding but possible. Additionally, by making an incision only at the upper margin of a nasoseptal mucosa (without making an incision on the nasal floor side), we can modify the size of the flap later, or we can reposition the flap if it will not be required. In our case, consequently, we could sufficiently repair with mucosal flaps of the inferior half of the left middle turbinate and sphenoid sinus; therefore, the prepared left nasoseptal flap was not used and repositioned.

Conclusion

Although spontaneous CSF leaks in adults with GSD and skull base defects are extremely rare, clinicians should pay attention to the characteristic radiological findings and consider surgical treatment that will help establish a pathological diagnosis. In such patients with CSF leaks due to skull base defects, in whom osteolysis has not crossed the midline, dural reconstruction after wide-range skull base exposure with EES may yield a good clinical outcome. We hope that our experience will aid the treatment of this challenging medical condition. Nonetheless, a comprehensive study of CSF leaks in GSD is required to develop new therapies with favorable long-term clinical outcomes.

Supplementary Material

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Author Contributions

Yusuke Morinaga and Hiroyoshi Akutsu were involved in study design. All authors critically revised the report, commented on drafts of the manuscript, and approved the final report.

Conflicts of Interest Disclosure

The authors declare no potential conflicts of interest.

References

- 1) Chang KJ, Yang MH, Li B, Huang H: Surgical management of Gorham-Stout syndrome involving the cervical spine with bilateral pleural effusion: A case report and literature review. *Exp Ther Med* 19: 3851-3855, 2020
- 2) Chrcanovic BR, Gomez RS: Gorham-Stout disease with involvement of the jaws: a systematic review. *Int J Oral Maxillofac Surg* 48: 1015-1021, 2019
- 3) Illeez OG, Ozkan K, Ozkan FU, et al.: Zoledronic acid: Treatment option for Gorham-Stout disease. *Orthopade* 47: 1032-1035, 2018
- 4) Kato H, Ozeki M, Fukao T, Matsuo M: Craniofacial CT findings of Gorham-Stout disease and generalized lymphatic anomaly. *Neuroradiology* 58: 801-806, 2016
- 5) Kim JH, Yoon DH, Kim KN, et al.: Surgical management of Gorham-Stout disease in cervical compression fracture with cervicothoracic fusion: Case report and review of literature. *World Neurosurg* 129: 277-281, 2019
- 6) Nozawa A, Ozeki M, Hori T, Kato H, Ohe N, Fukao T: Fatal progression of Gorham-Stout disease with skull base osteomyelitis and lateral medullary syndrome. *Intern Med* 58: 1929-1933, 2019
- 7) Nozawa A, Ozeki M, Kuze B, Asano T, Matsuoka K, Fukao T: Gorham-Stout disease of the skull base with hearing loss: dramatic recovery and antiangiogenic therapy. *Pediatr Blood Cancer* 63: 931-934, 2016
- 8) Ozeki M, Fujino A, Matsuoka K, Nosaka S, Kuroda T, Fukao T: Clinical features and prognosis of generalized lymphatic anomaly, kaposiform lymphangiomatosis, and Gorham-Stout disease. *Pediatr Blood Cancer* 63: 832-838, 2016
- 9) Ozeki M, Fukao T: Generalized lymphatic anomaly and Gorham-Stout disease: overview and recent insights. *Adv Wound Care (New Rochelle)* 8: 230-245, 2019
- 10) Ricci KW, Hammill AM, Mobberley-Schuman P, et al.: Efficacy of systemic sirolimus in the treatment of generalized lymphatic anomaly and Gorham-Stout disease. *Pediatr Blood Cancer* 66: e27614, 2019
- 11) Simon F, Luscan R, Khonsari RH, et al.: Management of Gorham Stout disease with skull-base defects: Case series of six children

- and literature review. *Int J Pediatr Otorhinolaryngol* 124: 152-156, 2019
- 12) Evans DA, Baugh RF, Gildsford JR, Heidelberger KP, Niparko JK: Lymphangiomas of skull manifesting with recurrent meningitis and cerebrospinal fluid otorrhea. *Otolaryngol Head Neck Surg* 103: 642-646, 1990
- 13) Evrenos MK, Ozkaya M, Yaman M, Proff LY: Case report: Gorham-Stout syndrome with involvement of majority of mandible, and partial maxillary, temporal and zygomatic bones. *J Maxillofac Oral Surg* 15: 335-338, 2016
- 14) Hernandez-Marques C, Gonzalez SA, Ortega FC, et al.: Gorham-Stout disease and cerebrospinal fluid otorrhea. *Pediatr Neurosurg* 47: 299-302, 2011
- 15) Hughes BD, Grant GA, Cummings TJ, Fuchs HE: Disappearing bone disease and Chiari I malformation. *Pediatr Neurosurg* 46: 58-61, 2010
- 16) Jea A, McNeil A, Bhatia S, et al.: A rare case of lymphangiomas of the craniocervical spine in conjunction with a Chiari I malformation. *Pediatr Neurosurg* 39: 212-215, 2003
- 17) Morimoto N, Ogiwara H, Miyazaki O, et al.: Gorham-Stout syndrome affecting the temporal bone with cerebrospinal fluid leakage. *Int J Pediatr Otorhinolaryngol* 77: 1596-1600, 2013
- 18) Mowry S, Canalis R: Gorham-Stout disease of the temporal bone. *Laryngoscope* 120: 598-600, 2010

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