—Case Reports—

Cerebrospinal Fluid Leakage Due to Dural Thinning after Endoscopic Pituitary Tumor Resection

Shinichiro Teramoto

Department of Neurosurgery, Juntendo University Graduate School of Medicine, Tokyo, Japan

Sellar reconstruction is important for preventing cerebrospinal fluid (CSF) leakage after transsphenoidal pituitary surgery. This report describes how, despite standard sellar reconstruction, CSF exudation resulted from dural thinning at the anterior skull base, outside the intrasellar area manipulated during pituitary tumor resection. A 76-year-old man underwent endoscopic transsphenoidal surgery for a pituitary tumor extending toward the anterior skull base. After opening the sellar floor, intractable bleeding from the anterior intercavernous sinus occurred during bone removal at the anterior skull base. Pseudocapsule-based extracapsular resection was completed after stopping the bleeding. On the 10th postoperative day, the patient developed CSF rhinorrhea complicated by marked pneumocephalus, and emergency endoscopic repair of the CSF leak was performed. CSF leakage originated from the thinned dura at the anterior skull base located outside the intrasellar area manipulated during tumor resection. The thinned dural area at the anterior skull base coincided with the site of intractable bleeding of the anterior intercavernous sinus during bone removal in tumor resection. The thinned anterior skull base dura was covered with fascia, overlaid with fat, and closed with the nasoseptal flap. Endoscopic CSF leak repair was successful. Severe damage to the anterior intercavernous sinus can cause extensive exposure of the single-layered inner meningeal dura, where thinning might result in CSF exudation. Therefore, use of autologous tissues to cover and reinforce the severely damaged area of the anterior intercavernous sinus might help prevent postoperative CSF exudation.

(J Nippon Med Sch 2025; 92: 111–115)

Key words: cerebrospinal fluid leakage, endoscopic transsphenoidal surgery, pituitary tumor, anterior intercavernous sinus, dural thinning

Introduction

Postoperative cerebrospinal fluid (CSF) leakage remains a major complication in transsphenoidal surgery for pituitary tumors. Recent meta-analyses indicate that postoperative CSF leakage associated with transsphenoidal surgery occurs in 3.4-5.6% of cases[1,2]. The risk of postoperative CSF leakage is increased in tumors with a diameter ≥40 mm, hard tumors, revision surgery, intraoperative CSF leakage, and tumors invading the cavernous sinus[1,2]. The endoscopic approach for transsphenoidal surgery seems to be more protective against CSF leakage than the microscopic approach[1], probably because the endoscopic close-up view can help identify the site of CSF leakage. Methods for preventing CSF leakage after pituitary surgery include filling the dead space of the sella turcica, watertight dural closure, reconstruction of the sellar floor with hard materials, and covering the dural defect with a vascularized pedicled flap[3]. Such methods are applied within the surgical area involved in intrasellar manipulation for pituitary tumor resection.

This report describes a case of CSF leakage after endoscopic transsphenoidal surgery, which was caused by dural thinning at the anterior skull base, outside the intrasellar area manipulated during pituitary tumor resection.

Correspondence to Shinichiro Teramoto, Department of Neurosurgery, Juntendo University Graduate School of Medicine, 3–1–3 Hongo, Bunkyo-ku, Tokyo 113–8431, Japan
E-mail: tera.2@hotmail.co.jp
https://doi.org/10.1272/jnms.JNMS.2025_92-102
Journal Website (https://www.nms.ac.jp/sh/jnms/)

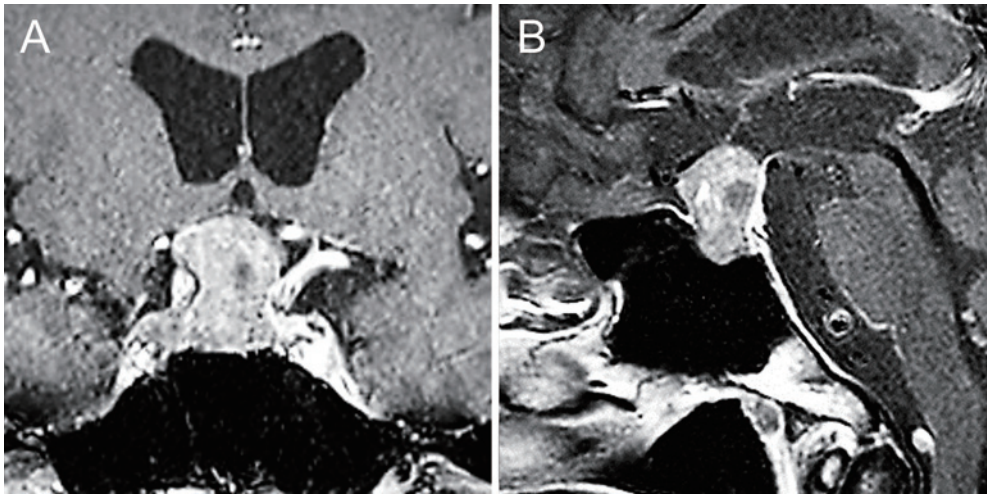

Fig. 1 Preoperative coronal (A) and sagittal (B) contrast-enhanced T1-weighted magnetic resonance images showing heterogeneous enhancement of a pituitary tumor compressing the optic nerve and extending toward the anterior skull base.

Case Presentation

A 76-year-old man presented with worsening visual acuity and bitemporal hemianopia caused by growth of a previously diagnosed pituitary tumor. Magnetic resonance imaging showed an intrasuprasellar pituitary tumor (maximum diameter, 25 mm) that was heterogeneously enhanced on contrast-enhanced T1-weighted imaging (**Fig. 1**). The pituitary tumor was classified as Knosp grade 0[4], was located medial to the medial tangent between the supraclinoid internal carotid artery and intracavernous internal carotid artery on coronal magnetic resonance images, and had compressed the optic nerve. Levels of pituitary hormone were within the normal range. Endoscopic transsphenoidal pituitary surgery was indicated because of the visual impairment caused by compression of the optic nerve by the tumor. Wide sphenoidotomy was performed via a right-sided unilateral paraseptal approach. To facilitate resection of the pituitary tumor, which extended toward the anterior skull base, the tuberculum sellae and planum sphenoidale were opened after opening the sellar floor. Intractable bleeding from the left anterior intercavernous sinus occurred during bone removal with a micro-Kerrison punch at the anterior skull base. The bleeding was stopped by repeated use of a flowable hemostatic agent and focal compression. Pseudocapsule-based extracapsular resection was performed after dural incision within the sellar floor, and the tumor, including the pseudocapsule, was completely resected. After observing no obvious injury to the sellar diaphragm and no active CSF leakage, the tumor resection cavity within the sella turcica was filled with fat harvested from the abdomen, and the dura was closed by suturing. Because the periosteal dural surface of the left anterior intercavernous sinus was severely damaged (**Fig. 2A**), the anterior skull base and sellar floor were reconstructed by the gasket-seal method[5], in which they were covered with collagen matrix (DuraGen, Integra LifeSciences, Plainsboro, NJ, USA) and fixed with bony nasal septum (**Fig. 2B**). After the Valsalva maneuver was used to confirm satisfactory sellar floor reconstruction without CSF leakage, fibrin coating was applied to the surgical field. The postoperative course after tumor resection was uneventful. However, on the 10th postoperative day the patient developed CSF rhinorrhea with severe headache, which was associated with marked acute pneumocephalus. Emergency endoscopic repair of the CSF leak was performed. After creating a right-sided vascularized pedicled nasoseptal flap, observation of the sellar floor revealed displacement of the bone for sellar floor reconstruction and exposure of the fat packed inside the sellar turcica. However, no obvious site of CSF leakage could be identified within the sella turcica. CSF leakage originated from the anterior skull base dura on the left side (**Fig. 3A**) and was caused by CSF exudation from thinning of the anterior skull base dura (**Fig. 3B**). The thinned dural area at the anterior skull base coincided with the site of intractable bleeding of the left anterior intercavernous sinus during bone removal in tumor resection. To prevent CSF exudation, the site of CSF leakage was covered with abdominal fascia (**Fig. 3C**) and then fibrin coating. Attempts to reconstruct the sellar floor with hard materials failed because of the high intrasellar pressure; thus, abdominal fat was overlaid from the sellar floor to the CSF leakage site

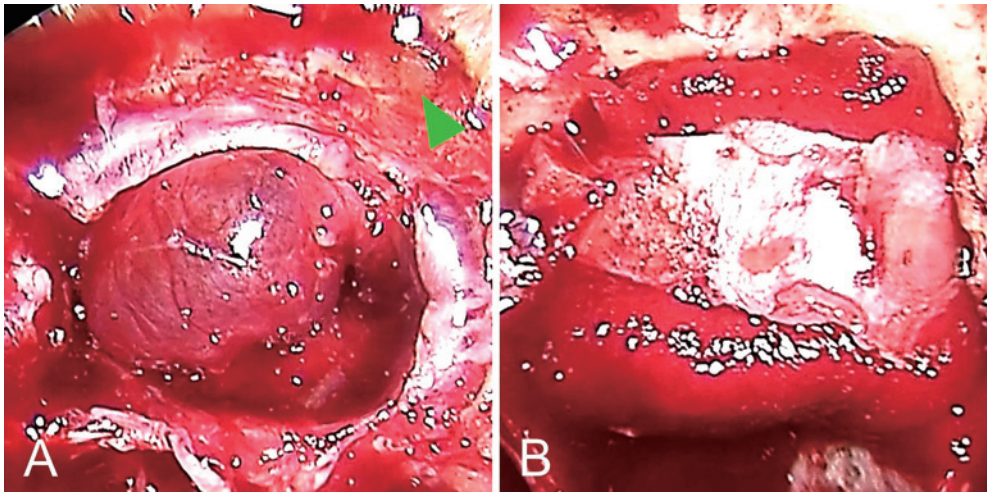

Fig. 2 Intraoperative photographs of endoscopic transsphenoidal resection of the pituitary tumor. (A) The periosteal dural surface of the left anterior intercavernous sinus is severely damaged (green arrowhead). (B) Reconstruction of the anterior skull base and sellar floor was performed with the gasket-seal method using bony nasal septum and collagen matrix (DuraGen) after fat filling of the sella turcica and dural suturing.

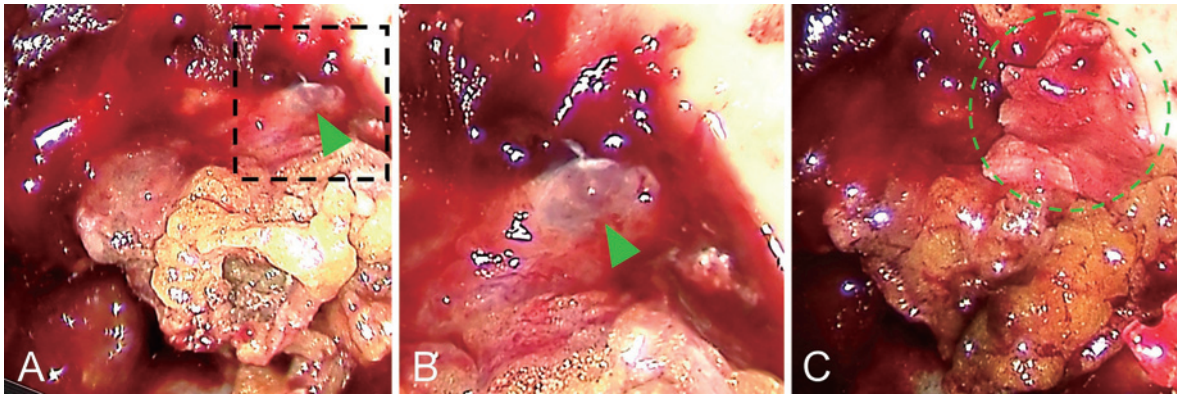

Fig. 3 Intraoperative photographs of endoscopic transsphenoidal repair of the cerebrospinal fluid (CSF) leak. (A) CSF leakage originates from the left anterior skull base dura rather than from within the sella turcica (green arrowhead). (B) Enlarged image of the dotted square in the left anterior skull base dural area with CSF leakage. CSF exudation resulting from thinning of the dura at the left anterior skull base coincides with the site of intractable bleeding of the anterior intercavernous sinus during bone removal in tumor resection (green arrowhead). (C) The thinned dural area at the left anterior skull base where CSF exuded was covered with autologous tissues, including abdominal fascia (green dotted circle).

at the anterior skull base, followed by fibrin coating. The surgical field was closed with the right-sided vascularized pedicled nasoseptal flap and fibrin coating. Endoscopic repair of the CSF leak was successful, and the postoperative course was uneventful. Postoperative magnetic resonance imaging confirmed total resection of the tumor and skull base reconstructed with autologous tissues (**Fig. 4**). Pneumocephalus and related symptoms, including headache, improved and the patient was discharged on foot after recovery of visual impairment. Histopathological examination of the pituitary tumor indicated that it was a gonadotroph pituitary neuroendocrine tumor.

The author certifies that he has obtained all appropriate patient consent.

Discussion

The anterior intercavernous sinus is located at the anterosuperior edge of the sellar turcica and consists of two dural layers: the meningeal dura (inner layer) and periosteal dura (outer layer)[6]. The anterior intercavernous sinus, which is the most common type of intercavernous sinus, is a voluminous venous interconnection that is vulnerable to damage during transsphenoidal surgery[7,8]. In-

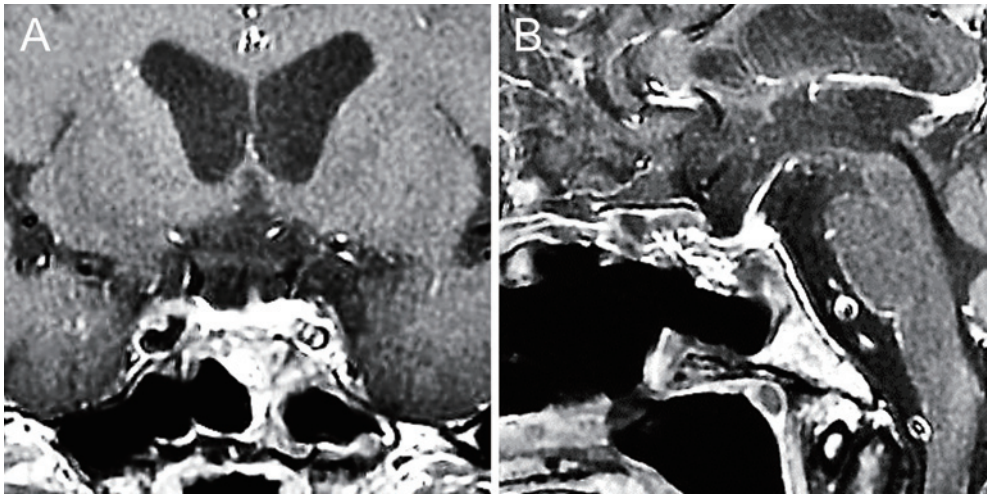

Fig. 4 Postoperative coronal (A) and sagittal (B) contrast-enhanced T1-weighted magnetic resonance images showing total resection of the pituitary tumor and skull base reconstructed with autologous tissues.

tractable bleeding from the anterior intercavernous sinus occurs in 5.4-7.7% of patients undergoing transsphenoidal surgery[9,10]. Hemostatic methods for transsphenoidal surgery include focal compression, direct suturing, bipolar coagulation, and use of hemostatic agents consisting of collagen, gelatin or oxidized cellulose, fibrin glue, bone wax, and epinephrine solution[9–12]. The outer dural surface of the anterior intercavernous sinus is planar and fragile, so direct suturing and bipolar coagulation are not advisable as hemostatic procedures[13,14]. Fibrin glue does not readily adhere to wet tissue and is weak in controlling active bleeding and is therefore unsuitable for immediate hemostasis[13,14]. Hemostasis with focal compression and hemostatic agents is therefore commonly used to control bleeding from the anterior intercavernous sinus. However, the present case suggests that repeated use of these hemostatic procedures may promote enlargement of the bleeding site, which is not easy to predict.

Enlargement of the bleeding site in the anterior intercavernous sinus is associated with exposure of the inner meningeal dura. Extensive exposure of the inner meningeal dura extends the single-layered dural area, which may be thinned by sustained CSF pulse pressure, potentially allowing exudation of CSF. The skull base area is particularly susceptible to changes in intracranial pressure, including CSF pulse pressure[15]. Hard reconstruction of the sellar floor suppresses the effects of CSF pulse pressure in transsphenoidal surgery and prevents postoperative CSF leakage. In the present case, despite hard sellar reconstruction, CSF exudation occurred in the anterior skull base dural area where the single-layered inner meningeal dura of the anterior intercavernous sinus was presumably mostly exposed. The anterior skull base dural area with CSF exudation was outside the sellar floor, which may have resulted in less counter-pressure effect due to hard sellar reconstruction. In pituitary tumors with a large suprasellar component, such as the present case, the arachnoid recess is usually anterior to the tumor because of displacement of the arachnoid membrane by the suprasellar tumor. Such cases are associated with CSF leakage from tearing after tumor resection and further tearing by excessive intrasellar filling[16]. The risk of CSF leakage due to tearing of the arachnoid recess can usually be confirmed by an intraoperative Valsalva maneuver. This case, however, was unrelated to tearing of the arachnoid recess, and CSF leakage could not be predicted by the Valsalva maneuver because the strength of the anterior skull base dura was maintained immediately after tumor resection.

Autologous tissues, including fascia, fat, and vascularized pedicled flaps, can be used as a dural substitute for repairing dural defects[17–19]. By ensuring adequate adhesion to the dural margin or by applying multiple layers, autologous tissues, even free, can serve as a long-term, durable dural substitute[18,19]. Therefore, covering the large exposed inner meningeal dura of the anterior intercavernous sinus with autologous tissues such as fat, fascia, and a vascularized pedicled sphenoid mucosal flap and nasoseptal flap may replace the outer dural layer. Reinforcing the single-layered inner meningeal dural area by covering it with autologous tissues could therefore prevent CSF exudation from dural thinning.

Conclusion

Severe damage to the anterior intercavernous sinus may result in extensive exposure of the inner meningeal dura. Because the large area of exposed single-layered inner meningeal dura increases the risk of CSF exudation from dural thinning, covering the severely damaged site of the anterior intercavernous sinus with autologous tissues during closure of the surgical field might help prevent postoperative CSF leakage.

Acknowledgements: None.

Financial support and sponsorship: This case report was supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI Grant Number JP 22K09242. The funding source was not involved in the study design, data collection, data analysis, writing of the report, or submission of the article.

Conflict of Interest: The author declares no conflicts of interest.

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(Received, October 5, 2023)
(Accepted, December 13, 2023)
(J-STAGE Advance Publication, June 18, 2024)