Late-Onset Intractable Cerebrospinal Fluid Leakage After Stereotactic Radiotherapy After Resection of Giant Nonfunctioning Pituitary Adenoma

Ayano Nihonmatsu, Fumihiko Nishimura, Yong-Soo Park, Yasushi Motoyama, Ichiro Nakagawa, Shuichi Yamada, Kentaro Tamura, Ryosuke Matsuda, Yasuhiro Takeshima, Yoshiaki Takamura, Hiroyuki Nakase

Key words
- Endoscopic endonasal surgery
- Late-onset cerebrospinal fluid leakage
- Nonfunctioning pituitary adenoma
- Stereotactic radiotherapy
- Transcranial approach

BACKGROUND: Late-onset skull base cerebrospinal fluid (CSF) leakage after stereotactic radiotherapy (SRT) is a very rare complication.

CASE DESCRIPTION: A 54-year-old woman came to our department for convulsions and was admitted. Brain magnetic resonance imaging revealed a giant tumor in the skull base region, including the sphenoid sinus, pituitary fossa, right cavernous sinus, right middle fossa, and right basal ganglia. Mild left hemiparesis was noted. An ophthalmologic examination revealed left side homonymous hemianopsia. Using an endonasal endoscopic surgical approach, tumor removal was performed, with the residual tumor removed with a transcranial approach. Residual tumor tissue remained around the right cavernous sinus; therefore, SRT was performed 1 month after the second procedure, which resulted in good control of growth. Four years later, spontaneous CSF leakage occurred, for which endoscopic endonasal surgery was performed. One month later, CSF leakage recurred, and the same procedure was again used. A third episode of recurrent CSF leakage occurred 5 days later. A transcranial approach was finally used for repair, and the patient showed complete recovery.

CONCLUSIONS: Late-onset CSF leakage after SRT for a pituitary adenoma can be intractable, and several aggressive repair procedures may be needed, including a combination of endonasal and transcranial approaches.

INTRODUCTION
Skull base cerebrospinal fluid (CSF) leakage after radiation therapy for a pituitary adenoma is a very rare complication. Although a leak may occur early after a transsphenoidal resection (TSR) procedure, late-onset leakage, even after resection of a large tumor, is quite uncommon, with a rate <1% in the 30- to 90-day window. Exceedingly rare cases of CSF leakage beyond the 6-month threshold after surgery have been reported.1-6 We present here a case of late-onset intractable CSF leakage after performing stereotactic radiotherapy (SRT) after resection of a giant nonfunctioning pituitary adenoma.

CASE DESCRIPTION
A 54-year-old woman came to our department for convulsions and was admitted. Brain magnetic resonance imaging revealed a giant tumor in the skull base region, including the sphenoid sinus, pituitary fossa, right cavernous sinus, right middle fossa, and right basal ganglia. Mild left hemiparesis was noted. An ophthalmologic examination revealed left side homonymous hemianopsia. Using an endonasal endoscopic surgical approach, tumor removal was performed, with the residual tumor removed with a transcranial approach. Residual tumor tissue remained around the right cavernous sinus; therefore, SRT was performed 1 month after the second procedure, which resulted in good control of growth. Four years later, spontaneous CSF leakage occurred, for which endoscopic endonasal surgery was performed. One month later, CSF leakage recurred, and the same procedure was again used. A third episode of recurrent CSF leakage occurred 5 days later. A transcranial approach was finally used for repair, and the patient showed complete recovery.
tomography scan findings showed severe pneumocephalus (Figure 5). We considered that repair using an endonasal approach would be difficult and chose a transcranial approach for the recurrent CSF leakage because of the wide working space, which was performed under a microscope with a right frontotemporal craniotomy. The leak point was in the tumor itself (Figure 6A) and sutured with 4–0 NUROLON (Suture Express, Overland Park, Kansas, USA) (Figure 6B), and then covered using right thigh fascia with microscopic visualization (Figure 6C). Lumbar drainage was applied for 7 days. Thereafter, the patient demonstrated full recovery from the late-onset intractable CSF leakage (Figure 7).

**DISCUSSION**

Late-onset CSF leakage is an exceedingly rare complication after neurosurgical intervention for a pituitary pathology.
Late-onset CSF leakage after TSR is relatively rare and nearly always occurs in the early postoperative period, with cases beyond the 6-month threshold scarcely encountered. Although several reports of late-onset CSF leakage after SRT in patients with functioning pituitary adenomas have been presented, the present is the first report of leak development that occurred >4 years after TSR and SRT in a patient with a nonfunctioning pituitary adenoma.

The overall rate of CSF leakage after TSR for a pituitary pathology is considered to be approximately 3.9%, with reported findings ranging from 0.5% to 15%.1,7,8 Rare case reports have documented delayed leakage, including Kudo et al.,3 who noted one at 7 months after TSR for a growth hormone–secreting adenoma, and the report by Ogawa and Tominaga2 of a case that occurred 10 years after combined TSR and gamma knife radiosurgery for a prolactinoma. Perry et al.9 also presented 2 cases with delayed CSF leakage after gamma knife radiosurgery, one with and the other without preceding TSR for a functioning pituitary adenoma. All patients in these reported cases were affected by a functioning pituitary adenoma, whereas the present case is the first case of late-onset CSF leakage after surgery and SRT for a nonfunctioning pituitary adenoma.

Treatment recommendations for CSF leakage are well established and generally consist of an operative repair procedure for surgical candidates, particularly in those who have previously undergone TSR.1,10-12 Many reported cases required operative repair, and moving directly to a surgical repair procedure without attempting a nonoperative modality remains justified.13 In the present case as well, a direct operative repair was performed 3 separate times without nonoperative management.

The fundamental principles of an open reconstruction procedure in any region include preference for vascularized tissue, such as the pericranial scalp flap, to promote more efficient wound healing.14-16 Ideally, in the present case, we should have mobilized a pedicle flap, such as the temporalis fascia or frontal galea, to cover the skull base after resection of the tumor, or repaired CSF leakage after surgery and performed irradiation. However, we only used free avascular fascia to cover the defect because of failure to obtain an adequate pedicle flap length.

The patient was affected by a giant pituitary adenoma invading the right cavernous sinus and right middle fossa. Even after 2-stage surgery with transphenoidal and transcranial approaches,
the residual tumor remained in the right cavernous sinus and right middle fossa. The reason why late-onset CSF leakage 4 years after SRT occurred in the present case may because of tumor shrinkage, which is thought to result in uncovering of bony defects formed by late tumor regression. To prevent late-onset CSF leakage, skull base reconstruction should be considered during surgery for tumor removal if radiation therapy is introduced at a later time.

**CONCLUSIONS**

Late-onset CSF leakage after SRT for a giant nonfunctioning pituitary adenoma can be intractable with several additional aggressive repair procedures possibly required, including a combination of endonasal and transcranial approaches. Should SRT be considered after tumor removal surgery, tight skull base reconstruction may be advisable during tumor removal surgery to prevent a future late-onset CSF leak after SRT.

**REFERENCES**

1. Han ZL, He DS, Mao ZG, Wang HJ. Cerebrospinal fluid rhinorrhea following trans-sphenoidal pituitary macroadenoma surgery; experience from 592 patients. Clin Neurol Neurosurg. 2008;110:570-579.

2. Ogawa Y, Tominaga T. Delayed cerebrospinal fluid leakage 10 years after transsphenoidal surgery and gamma knife surgery — case report. Neurol Med Chir (Tokyo). 2007;47:483-485.

3. Kudo H, Sakagami Y, Kawamura A, Tamaki N. Delayed cerebrospinal fluid rhinorrhea seven months after transsphenoidal surgery for pituitary adenoma — case report. Neurol Med Chir (Tokyo). 2000;40:160-165.

4. Nishioka H, Haraoaka I, Ikeda Y. Risk factors of cerebrospinal fluid rhinorrhea following trans-sphenoidal surgery. Acta Neurochir (Wien). 2005;147:1163-1166.

5. Rabadán AT, Hernández D, Ruggeri CS. Pituitary tumors: our experience in the prevention of postoperative cerebrospinal fluid leaks after transsphenoidal surgery. J Neurosurg. 2009;95:33-137.

6. Thorp BD, Sreenath SB, Ebert CS, Zanation AM. Endoscopic skull base reconstruction: a review and clinical case series of 152 vascularized flaps used for surgical skull base defects in the setting of intraoperative cerebrospinal fluid leak. Neurosurg Focus. 2014;37:E4.

7. Seiler RW, Mariani L. Sellar reconstruction with resorbable vicryl patches, gelatin foam, and fibrin glue in transsphenoidal surgery: a 10-year experience with 376 patients. J Neurosurg. 2000;93:762-765.

8. Burkey BB, Speyer MT, Maciunas RJ, Fitzpatrick JM, Galloway RL, Allen GS. Sublabial, transseptal, transsphenoidal approach to the pituitary region guided by the ACUSTAR I system. Otolaryngol Head Neck Surg. 1998;118:191-194.

9. Perry A, Graffeo CS, Copeland WR III, et al. Delayed cerebrospinal fluid rhinorrhea after gamma knife radiosurgery with or without preceding transsphenoidal resection for pituitary pathology. World Neurosurg. 2017;100:201-207.

10. Black PM, Zervas NT, Candia GL. Incidence and management of complications of transsphenoidal operation for pituitary adenomas. Neurosurgery. 1987;20:920-924.

11. Cappabianca P, Cavallo LM, Colao A, de Divitiis E. Surgical complications associated with the endoscopic endonasal transsphenoidal approach for pituitary adenomas. J Neurosurg. 2002;97:293-298.

12. Couldwell WT, Kan P, Weiss MH. Simple closure following transsphenoidal surgery. Technical note. Neurosurg Focus. 2006;20:E1.

13. Lam G, Mehta V, Zada G. Spontaneous and medically induced cerebrospinal fluid leakage in the setting of pituitary adenomas: review of the literature. Neurosurg Focus. 2012;33:E2.

14. Zanation AM, Snyderman CH, Carrau RL, Kassam AB, Gardner PA, Prevedello DM.
Minimally invasive endoscopic pericranial flap: a new method for endonasal skull base reconstruction. Laryngoscope. 2009;119:13-18.

15. Patel MR, Stadler ME, Snyderman CH, et al. How to choose? Endoscopic skull base reconstructive options and limitations. Skull Base. 2010;20:397-404.

16. Patel MR, Shah RN, Snyderman CH, et al. Pericranial flap for endoscopic anterior skull-base reconstruction: clinical outcomes and radi-anatomic analysis of preoperative planning. Neurosurg. 2010;66:506-512.

Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received 11 May 2019; accepted 20 June 2019