

Delayed remote cerebellar hemorrhage after unilateral biportal endoscopic lumbar decompression: a case report and literature review

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Case Report

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Abstract

Background

Remote cerebellar hemorrhage is a rare but potentially life-threatening complication of spinal surgery and is commonly associated with dural injury and cerebrospinal fluid loss. Intracranial complications after irrigation-assisted spinal endoscopy are poorly recognized, particularly when no dural tear is identified and the initial head computed tomography is unremarkable.

Case presentation

A 55-year-old man with lumbar spinal stenosis underwent unilateral biportal endoscopic decompression at L4–5. No definite dural tear or cerebrospinal fluid leakage was identified intraoperatively. During emergence from anesthesia, he developed marked agitation, hypertension, and tachycardia, although immediate postoperative head computed tomography (CT) showed no definite abnormality. By postoperative day 1, 550 mL of bloody fluid had drained from the lumbar wound. He subsequently developed hypoxemia, nuchal rigidity, and right-sided weakness. Repeat head CT revealed bilateral cerebellar hemorrhage, subarachnoid hemorrhage, and obstructive hydrocephalus. Emergency external ventricular drainage was performed. With multidisciplinary treatment, neurological function gradually improved. At the 2-month follow-up, right-sided muscle strength was grade 4, and he was able to walk independently.

Conclusions

Unexplained agitation, hypertension, and tachycardia during emergence from anesthesia after UBE should prompt consideration of an irrigation-related craniospinal pressure disturbance. When these signs are accompanied by unexpectedly high wound drainage, nuchal rigidity, or a new neurological deficit, occult cerebrospinal fluid leakage and delayed intracranial complications—including remote cerebellar hemorrhage, subarachnoid hemorrhage, and hydrocephalus—should be considered. Serial neurological assessment and timely repeat neuroimaging are warranted even when the initial head CT is unremarkable.

Background

Over the past decade, unilateral biportal endoscopy (UBE) has gained increasing acceptance as a minimally invasive technique for degenerative lumbar disorders, including lumbar spinal stenosis, lumbar disc herniation, and lumbar spondylolisthesis [1, 2]. As its use has expanded, procedure-related complications have been increasingly recognized. Reported complications include epidural hematoma, dural tear, inadequate decompression, transient neurological deficits, and postoperative infection [3].

Remote cerebellar hemorrhage (RCH) is a rare but potentially life-threatening intracranial complication following spinal surgery and is commonly associated with dural injury and perioperative cerebrospinal fluid (CSF) loss [4]. Clinical manifestations vary and may include headache, altered consciousness, delayed emergence, and focal neurological deficits. In this patient, agitation, hypertension, and tachycardia developed during anesthetic emergence despite an initially unremarkable head CT. Markedly increased wound drainage and delayed intracranial hemorrhage subsequently occurred. This report describes the clinical course, management, and potentially contributing factors, with the aim of improving early recognition and perioperative management of similar intracranial complications after UBE.

Case presentation

Patient history and preoperative assessment

A 55-year-old man presented with a 6-month history of low back pain radiating to the left lower extremity, predominantly along the posterior aspect of the left lower leg, accompanied by intermittent claudication. Conservative treatment provided insufficient relief. His medical history was notable for hypertension of more than 8 years, for which he was receiving oral

antihypertensive therapy. He had no known coagulation disorder or history of lumbar surgery and was not receiving antiplatelet or anticoagulant therapy.

On admission, the patient was alert and cooperative, with a blood pressure of 100/72 mmHg. Neurological examination showed grade 5 muscle strength in both lower extremities, normal sensation, and a positive straight-leg-raising test on the left side. Preoperative lumbar computed tomography and magnetic resonance imaging demonstrated spinal canal and lateral recess stenosis at L4–5. His platelet count and coagulation parameters were within the normal ranges. Based on the clinical and imaging findings, lumbar spinal stenosis at L4–5 was diagnosed.

Surgical procedure and early postoperative course

Because symptoms persisted despite conservative treatment, unilateral biportal endoscopic decompression was performed at L4–5 under general anesthesia. No definite dural tear or CSF leakage was identified, and a lumbar wound drain was placed.

During emergence from anesthesia, however, the patient became markedly agitated and was unable to follow commands or cooperate with the examination. His pupils were equal and round. Because of this atypical emergence, he was transferred to the intensive care unit (ICU) for further monitoring. On ICU admission, agitation persisted. His heart rate was 121 beats/min, and his blood pressure was 175/98 mmHg. Muscle tone was mildly increased in all four extremities. The Glasgow Coma Scale (GCS) score was 12 (E4V3M5). An immediate noncontrast head CT showed no definite intracranial abnormality.

Four hours after surgery, the lumbar wound drain had produced 20 mL of bloody fluid. By 07:00 on postoperative day 1, the cumulative output had reached 550 mL. The patient opened his eyes spontaneously and followed simple commands, but intermittent agitation and slurred speech persisted. His GCS score was 15 (E4V5M6). After reassessment, the lumbar wound drain was removed at 13:00.

Diagnostic assessment and treatment

Approximately 1 hour after drain removal, his oxygen saturation acutely decreased to 88%, accompanied by tachypnea, diffuse bilateral pulmonary crackles, nuchal rigidity, and new right-sided weakness. Muscle strength in the right upper and lower extremities decreased to grade 1–2, while nonpurposeful movements were observed on the left side. His pupils remained equal and round but reacted sluggishly to light. The right Babinski sign was equivocal, and the GCS score was 12 (E3V3M6). Chest radiography was interpreted as showing possible bilateral pneumonia or pulmonary edema. Endotracheal intubation and invasive mechanical ventilation were initiated.

Repeat head CT revealed multiple scattered hemorrhagic foci in both cerebellar hemispheres with surrounding edema. The supratentorial ventricular system was enlarged, consistent with hydrocephalus. Diffuse cerebral swelling with effacement of the ambient and prepontine cisterns raised concern for impending brain herniation. Subarachnoid hemorrhage was also present. Following urgent neurosurgical consultation, an external ventricular drain (EVD) was placed at approximately 17:00. Preprocedural head and neck computed tomography angiography (CTA) suggested a small aneurysm in the proximal basilar artery. Subsequent digital subtraction angiography (DSA) showed no definite structural vascular lesion, including an aneurysm or arteriovenous malformation; marked cerebral vasospasm was noted.

At the time of acute deterioration, pulmonary infection or pulmonary edema was initially considered because of the hypoxemia and bilateral pulmonary crackles. After repeat head CT demonstrated cerebellar hemorrhage, subarachnoid hemorrhage, and hydrocephalus, a ruptured intracranial aneurysm or arteriovenous malformation was also considered. CTA suggested a small proximal basilar artery aneurysm, whereas DSA showed no definite structural vascular lesion. In the context of unexpectedly high postoperative wound drainage, RCH associated with possible occult CSF loss was therefore considered the most plausible working diagnosis.

After EVD placement, neurocritical care and respiratory support were provided. Serial head CT showed progressive resolution of the cerebellar hemorrhage without worsening cerebral edema. Serial head CT findings from postoperative day 0 to

postoperative day 19 are shown in Fig. 1.

On postoperative day 12, the EVD was temporarily clamped. During the clamping trial, oxygen saturation acutely decreased to 68%. The drain was reopened, and invasive mechanical ventilation was resumed. On postoperative day 13, a second clamping trial was performed. Head CT obtained after 2 hours of clamping showed no ventricular enlargement or worsening hydrocephalus. In view of the radiographic stability, the EVD was subsequently removed.

On postoperative day 14, the patient passed a cuff-leak test and was successfully extubated. Supplemental oxygen was then administered through a nasal cannula. Cranial MRI, including diffusion-weighted imaging, performed on postoperative day 15 revealed an acute right frontal infarction. Following joint evaluation by the neurology and neurosurgery teams, neither anticoagulant nor antiplatelet therapy was initiated because of the recent severe subarachnoid hemorrhage. Supportive neurological management was continued.

Outcome and follow-up

Outcome and follow-up

By postoperative day 17, the patient was alert, communicated using simple phrases, and had stable vital signs. Muscle strength improved to grade 3 on the right and remained grade 5 on the left. The preoperative radicular pain had also improved substantially. His GCS score was 15 (E4V5M6). He was subsequently transferred from the ICU to the orthopedic ward for continued treatment and rehabilitation of the right-sided weakness.

The nasogastric tube was removed on postoperative day 29 after recovery of adequate swallowing function. Following continued rehabilitation, including acupuncture and limb rehabilitation exercises, right-sided muscle strength improved to grade 4 by postoperative day 34. The patient was able to ambulate independently for 50–100 m. At the 2-month follow-up, right-sided muscle strength remained grade 4, and the preoperative radicular pain had completely resolved. The perioperative clinical course, management, and short-term follow-up are summarized in Fig. 2.

Patient perspective

The patient reported complete resolution of the preoperative radiating leg pain and recovery of independent walking at the 2-month follow-up. He remained concerned about the residual right-sided weakness but considered his overall functional recovery satisfactory.

Discussion and conclusions

Remote cerebellar hemorrhage is a rare but potentially life-threatening complication of spinal surgery. A systematic review found that approximately 93% of reported cases were associated with intraoperative dural injury, supporting a close relationship between dural disruption, cerebrospinal fluid (CSF) loss, and RCH [4]. Clinical manifestations may include headache, nausea, altered consciousness, delayed emergence from anesthesia, seizures, and focal neurological deficits [4, 5]. In the present patient, marked agitation, hypertension, and tachycardia occurred during anesthetic emergence, although immediate head CT showed no definite abnormality. Bilateral RCH, subarachnoid hemorrhage, and obstructive hydrocephalus became evident only after neurological deterioration on postoperative day 1. This sequence highlights that clinically important intracranial complications may precede their radiographic detection.

In the present case, no dural tear or CSF leakage was recognized intraoperatively. Agitation, hypertension, and tachycardia developed during anesthetic emergence despite an initially unremarkable head CT. Following markedly increased wound drainage, neurological and respiratory deterioration occurred on postoperative day 1, and repeat CT demonstrated bilateral RCH, subarachnoid hemorrhage, and obstructive hydrocephalus.

Previous reports have described delayed recovery of consciousness, altered mental status, and seizures as early manifestations of RCH after spinal surgery [5]. RCH has also been reported despite the absence of a recognized intraoperative dural injury, with

an occult dural defect identified during subsequent evaluation [6]. These observations, together with the present clinical course, suggest that unexplained agitation, hypertension, and tachycardia during anesthetic emergence may precede radiographic evidence of hemorrhage and may represent nonspecific but clinically important warning signs.

UBE relies on continuous irrigation to establish and maintain a clear operative field. Irrigation pressure may be transmitted cranially through the epidural space and alter craniospinal pressure dynamics. In an intraoperative monitoring study of 20 patients undergoing biportal endoscopic lumbar discectomy, cervical epidural pressure increased substantially after the operative working space communicated with the epidural space and was positively correlated with irrigation pressure [7]. These findings underscore the importance of maintaining unobstructed irrigation outflow and avoiding excessive irrigation pressure.

A recent fresh-cadaver study demonstrated rapid increases in measured intracranial pressure after continuous irrigation was initiated, with the magnitude of change influenced by the irrigation method, endoscopic system, and patency of the outflow pathway [8]. Although these findings were experimental, they support the biological plausibility of irrigation-related craniospinal pressure transmission. If a recognized or occult dural defect is present, irrigation fluid could theoretically enter the intradural space, allowing pressure changes to be transmitted more readily through the CSF pathway.

Guo et al. reported five severe irrigation-related complications associated with dural injury during UBE. All five patients developed otherwise unexplained hypertension and tachycardia during anesthetic recovery, and most also had marked agitation, headache, low back pain, or increased muscle tone [9]. These findings resemble the early clinical features in the present case. The unexplained hypertension, tachycardia, and agitation may therefore have reflected an irrigation-related craniospinal pressure disturbance. However, intracranial, intraspinal, and irrigation pressures were not directly monitored, and pain, anesthetic emergence, and pre-existing hypertension could have produced similar findings. Therefore, these observations support the possibility of an irrigation-related craniospinal pressure disturbance but do not establish causality. To place these early warning signs in the broader context of structural intracranial complications after irrigation-assisted spinal endoscopy, we conducted a focused review of the published cases.

As summarized in Table 1, serious intracranial complications after irrigation-assisted spinal endoscopy have been reported only sporadically. Lin et al. described pneumocephalus with impaired consciousness and seizure after full-endoscopic lumbar discectomy complicated by an intraoperative dural tear [10]. Yang et al. reported diffuse symptomatic pneumocephalus after biportal endoscopic decompression, in which no dural tear was recognized intraoperatively, although substantial cerebrospinal fluid drainage was subsequently observed [11]. Zhang et al. documented nonaneurysmal subarachnoid hemorrhage after full-endoscopic transforaminal lumbar interbody fusion without an identified dural injury or definite cerebrospinal fluid leakage [12]. In a three-case series, Vargas et al. reported subarachnoid hemorrhage with intraventricular hemorrhage and hydrocephalus, as well as intracranial air, following endoscopic procedures complicated by incidental durotomy [13]. Xie et al. described a fatal case of bilateral frontal and parietal intracranial hemorrhage with subarachnoid hemorrhage after endoscopic lumbar decompression [14]. More recent reports of biportal or uniportal endoscopic surgery have also described pneumocephalus accompanied by delayed emergence, agitation, seizures, hypertension, tachycardia, or other neurological abnormalities [15–17].

Table 1
Published serious intracranial complications after irrigation-assisted spinal endoscopy

Reference	Age/Sex	Procedure/Level	Dural injury or CSF clue	Initial manifestations	Intracranial findings	Outcome
Lin et al. [10]	63/M	FELD, L3–4	Recognized dural tear	Failed emergence, tachypnea, seizure	Pneumocephalus	Recovered without neurological sequelae
Yang et al. [11]	79/F	BESS/UBE decompression, L4–5	No recognized tear; postoperative CSF drainage	Headache, nausea, dizziness	Diffuse pneumocephalus	Recovered
Zhang et al. [12]	62/M	FE-TLIF, L4–5	No recognized tear or definite CSF leak	Neck pain, headache, nausea, vomiting	Nonaneurysmal SAH	Recovered
Vargas et al. [13], Case 1	52/F	Endoscopic decompression, C6–7	Recognized durotomy	Neck pain, headache, diplopia	SAH, IVH, and hydrocephalus	Improved
Vargas et al. [13], Case 2	NR/M	Endoscopic lumbar decompression, L4–5	Recognized durotomy	Seizure, arrhythmia, hypotension	Pneumocephalus	Improved
Vargas et al. [13], Case 3	NR/M	Endoscopic lumbar decompression	Recognized durotomy	Seizure, arrhythmia, hypotension	NR	Improved
Xie et al. [14]	54/M	Endoscopic laminectomy/discectomy, L5–S1	Recognized dural tear with CSF leakage	Loss of consciousness, limb twitching	Intracranial hemorrhage with SAH	Died
Han et al. [15]	70/F	UBE transforaminal procedure, L5–S1	Suspected dural injury	Hypertension, tachycardia, confusion, neck stiffness	Pneumocephalus compressing the brainstem	Recovered
Xie et al. [16]	54/M	UBE decompression, L5–S1	No recognized tear; postoperative CSF clue	Delayed awakening, agitation, spasms	Pneumocephalus	Recovered without neurological sequelae
Huang et al. [17]	29/M	Uniportal endoscopic discectomy, L5–S1	Occult dural tear	Confusion, agitation, seizure	Pneumocephalus	Recovered
Abbreviations: BESS, biportal endoscopic spinal surgery; CSF, cerebrospinal fluid; F, female; FE-TLIF, full-endoscopic transforaminal lumbar interbody fusion; FELD, full-endoscopic lumbar discectomy; IVH, intraventricular hemorrhage; M, male; NR, not reported; SAH, subarachnoid hemorrhage; UBE, unilateral biportal endoscopy.						

Collectively, these reports demonstrate heterogeneous intracranial manifestations but recurrent associations with recognized or occult dural injury, continuous irrigation, postoperative drainage, and abnormal communication with the cerebrospinal fluid pathway. Within the verified search range, we did not identify a previously published case of remote cerebellar hemorrhage following spinal endoscopy. The present case therefore broadens the reported spectrum by demonstrating delayed bilateral remote cerebellar hemorrhage, subarachnoid hemorrhage, and obstructive hydrocephalus after an initially unremarkable head CT and markedly increased postoperative wound drainage. These features provide a clinical basis for considering occult cerebrospinal fluid loss and a related venous mechanism in the present patient.

Against this background, the most widely accepted explanation for RCH after spinal surgery is a venous mechanism related to CSF loss, although the precise pathophysiology remains incompletely understood [4, 18]. Persistent CSF loss may lower intracranial pressure and produce caudal displacement of the cerebellum. The resulting traction on cerebellar draining veins may lead to venous congestion, hemorrhage, or rupture [18, 19]. Small dural defects at the nerve root sleeve or within areas of local adhesion may also be difficult to identify intraoperatively [4, 6].

In this patient, no definite dural tear or CSF leakage was observed during surgery, and drainage did not increase abnormally during the first 4 postoperative hours. However, approximately 550 mL of bloody fluid drained from the lumbar wound overnight. Because the fluid was not analyzed, its composition could not be determined and may have included blood, tissue fluid, and residual irrigation fluid. It therefore cannot be regarded as confirmed CSF. Nevertheless, the subsequent development of RCH and hydrocephalus makes the presence of CSF within the mixed drainage a clinically plausible possibility.

Suzuki et al. described a patient who developed impaired consciousness and RCH approximately 12 hours after spinal surgery following drainage of 850 mL of bloody fluid through a negative-pressure drain [20]. Friedman et al. also suggested that postoperative wound suction may maintain or aggravate CSF loss and that related symptoms may improve after suction is discontinued [19].

In the present case, marked neurological deterioration occurred approximately 1 hour after removal of the lumbar drain. This temporal association does not establish drain removal as the trigger. The underlying pathological process may already have evolved during the preceding period of sustained drainage. Because no CSF-specific testing was performed and no dural defect was confirmed, occult CSF leakage remains a clinically plausible hypothesis rather than a proven diagnosis.

Potential contributing factors should be considered separately. Hypertension has frequently been reported in patients with RCH after spinal surgery, but it has not been established as an independent cause [4, 18]. Numaguchi et al. found no significant difference in peak perioperative blood pressure or postoperative drainage volume between patients with dural tears who did and did not develop RCH, suggesting that the event may depend on the combined effects of the rate of CSF loss, craniospinal pressure changes, and individual susceptibility [21]. In the present patient, long-standing hypertension and a marked blood pressure increase during anesthetic emergence may have increased vascular vulnerability to acute hemodynamic changes, although this remains speculative.

Degenerative lumbar pathology may have contributed through a different pathway by increasing the likelihood of an occult dural injury. Previous UBE studies have identified lumbar spinal stenosis, bilateral decompression, and revision surgery as potential risk factors for dural tear [22–25]. Hypertrophy of the ligamentum flavum, local adhesions, and dural vulnerability may further increase the risk of an unrecognized small dural defect [22, 26–28]. Taken together, a multifactorial mechanism involving pre-existing hypertension, degenerative stenosis with possible dural vulnerability, continuous irrigation, and sustained postoperative drainage appears plausible, but no single factor can be identified as causal.

When abnormal anesthetic emergence, unexpectedly high wound drainage, and progressive neurological signs occur after UBE, clinicians should consider an irrigation-related craniospinal pressure disturbance, occult CSF leakage, and delayed intracranial hemorrhage rather than attributing the findings solely to anesthetic effects or postoperative pain.

Most reported intracranial hemorrhages after spinal surgery occur within the first 48 postoperative hours. Early manifestations may include headache, nuchal rigidity, altered consciousness, focal neurological deficits, or delayed emergence from anesthesia [29, 30]. Irrigation-related complications associated with dural injury during UBE may also present with otherwise unexplained hypertension, tachycardia, and marked agitation [9]. When these findings occur, prompt neurological reassessment and head CT are indicated. Repeat imaging should be obtained if symptoms persist or worsen, even when the initial study is unremarkable.

Unexpectedly high or atypical wound drainage should prompt reassessment of the indication for drainage, the use of negative pressure, and the possibility of occult CSF loss. Drain management should balance the risk of continued CSF loss against the risks of postoperative hematoma and neural compression [19, 20].

Once RCH is diagnosed, the choice between conservative treatment and neurosurgical intervention should be guided by the level of consciousness, hemorrhage burden, posterior fossa mass effect, brainstem compression, and severity of hydrocephalus. Progressive neurological deterioration, obstructive hydrocephalus, or substantial posterior fossa mass effect should prompt urgent neurosurgical assessment. Early collaboration among spine surgeons, neurosurgeons, neurologists, anesthesiologists, and critical care specialists may facilitate timely treatment and improve outcomes.

Limitations

A strength of this report is the detailed perioperative timeline supported by serial neuroimaging, vascular imaging, neurological assessments, and short-term functional follow-up. However, several limitations remain. Irrigation pressure, total irrigation volume, intracranial pressure, and intraspinal pressure were not continuously recorded. No definite dural defect was identified, and the postoperative drainage fluid was not tested for β 2-transferrin or β -trace protein; occult CSF leakage therefore remains an inference rather than a confirmed diagnosis. Dedicated cerebral venous imaging was not performed, and the precise mechanism of hemorrhage could not be established. Complete hemodynamic data during anesthetic emergence were also unavailable. Finally, this is a single case with a 2-month follow-up, so the proposed associations among continuous irrigation, sustained drainage, possible CSF loss, and delayed RCH should be regarded as hypothesis-generating rather than causal.

Conclusions

Unexplained agitation, hypertension, and tachycardia during emergence from anesthesia after UBE may represent early warning signs of a craniospinal pressure disturbance. When these abnormalities are accompanied by unexpectedly high wound drainage, nuchal rigidity, altered consciousness, or a new neurological deficit, occult CSF loss and delayed intracranial complications should be considered. An initially unremarkable head CT does not exclude an evolving complication; persistent or progressive symptoms warrant repeat neuroimaging. Careful drain management, serial neurological assessment, and early multidisciplinary intervention may facilitate timely diagnosis and treatment.

Abbreviations

AVM: arteriovenous malformation; BESS: biportal endoscopic spinal surgery; CSF: cerebrospinal fluid; CT: computed tomography; CTA: computed tomography angiography; DSA: digital subtraction angiography; EVD: external ventricular drain; FE-TLIF: full-endoscopic transforaminal lumbar interbody fusion; FELD: full-endoscopic lumbar discectomy; GCS: Glasgow Coma Scale; ICU: intensive care unit; IVH: intraventricular hemorrhage; MRI: magnetic resonance imaging; POD: postoperative day; RCH: remote cerebellar hemorrhage; SAH: subarachnoid hemorrhage; UBE: unilateral biportal endoscopy.

Declarations

Ethics approval and consent to participate

According to the institutional policy of Hospital of Chengdu University of Traditional Chinese Medicine, formal ethics approval was not required for this single-patient case report. This determination was confirmed by the Ethics Committee of Hospital of Chengdu University of Traditional Chinese Medicine (reference number: 2025KL-126).

Clinical trial number

Not applicable.

Consent for publication

Written informed consent was obtained from the patient for the publication of this case report and all accompanying clinical information and images.

Availability of data and materials

All data supporting the findings of this case report are included in this article. Additional de-identified information may be available from the corresponding author on reasonable request, subject to patient privacy and institutional requirements.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

RC and FY performed the surgery. YG drafted the manuscript. JS conducted the literature search and reviewed the relevant literature. MJ prepared the figures and table. XC critically reviewed and revised the manuscript. All authors read and approved the final manuscript.

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Authors' information

Not applicable.

References

1. Eum JH, Heo DH, Son SK, Park CK. Percutaneous biportal endoscopic decompression for lumbar spinal stenosis: a technical note and preliminary clinical results. *J Neurosurg Spine*. 2016;24:602–7. 10.3171/2015.7.SPINE15304.
2. Yu Z, Ye C, Alhendi MA, Zhang H. Unilateral biportal endoscopy for the treatment of lumbar disc herniation. *J Vis Exp*. 2023;202:e65497. 10.3791/65497.
3. Kim W, Kim SK, Kang SS, Park HJ, Han S, Lee SC. Pooled analysis of unsuccessful percutaneous biportal endoscopic surgery outcomes from a multi-institutional retrospective cohort of 797 cases. *Acta Neurochir (Wien)*. 2020;162:279–87. 10.1007/s00701-019-04162-2.
4. Sturiale CL, Rossetto M, Ermani M, Baro V, Volpin F, Milanese L, et al. Remote cerebellar hemorrhage after spinal procedures (part 2): a systematic review. *Neurosurg Rev*. 2016;39:369–76. 10.1007/s10143-015-0673-8.

5. Lee HY, Kim SH, So KY. Seizure and delayed emergence from anesthesia resulting from remote cerebellar hemorrhage after lumbar spine surgery: a case report. *Korean J Anesthesiol.* 2012;63:270–3. 10.4097/kjae.2012.63.3.270.
6. Haller JM, Calvert G, Spiker WR, Brodke DS, Lawrence BD. Remote cerebellar hemorrhage after revision lumbar spine surgery. *Global Spine J.* 2015;5:535–7. 10.1055/s-0035-1567839.
7. Kang T, Park SY, Lee SH, Park JH, Suh SW. Assessing changes in cervical epidural pressure during biportal endoscopic lumbar discectomy. *J Neurosurg Spine.* 2021;34:196–202. 10.3171/2020.6.SPINE20586.
8. Ozturk M, Dolas I, Yorukoglu AG, Dolen D, Unal TC, Ozler D, et al. Pressure changes at spinal epidural and intracranial regions in fresh cadavers during full endoscopic lumbar spine surgery with continuous irrigation. *J Orthop Surg Res.* 2025;20:618. 10.1186/s13018-025-06023-4.
9. Guo J, Zhou F, Qian Y, Qiu Y, Han S, Xu J. Dural tear with severe irrigation-related complications during unilateral biportal endoscopy under general anesthesia: a case series and literature review. *Front Med (Lausanne).* 2026;13:1776670. 10.3389/fmed.2026.1776670.
10. Lin CH, Lin SM, Lan TY, Pao JL. Pneumocephalus with conscious disturbance after full-endoscopic lumbar discectomy. *World Neurosurg.* 2019;131:112–5. 10.1016/j.wneu.2019.07.200.
11. Yang CT, Chiu CD, Wu CY. Diffuse symptomatic pneumocephalus after biportal endoscopic spinal surgery: illustrative case. *J Neurosurg Case Lessons.* 2022;3:CASE22168. 10.3171/CASE22168.
12. Zhang J, Xue Y, Gao J, Li Y, Shi K, Diao W, et al. Subarachnoid hemorrhage after full endoscopic transforaminal lumbar interbody fusion: a case report. *Br J Neurosurg.* 2023;37:1757–60. 10.1080/02688697.2021.1902473.
13. Vargas RAA, Hagel V, Zhang X, Yang H, Ramírez León JF, Lorio M, et al. Durotomy- and irrigation-related serious adverse events during spinal endoscopy: illustrative case series and international surgeon survey. *Int J Spine Surg.* 2023;17:387–98. 10.14444/8454.
14. Xie Y, Mei X, Liu S, Fiani B, Fan X, Yu Y. Postoperative intracranial hemorrhage after an endoscopic L5-S1 laminectomy and discectomy: a case report and literature review. *J Pers Med.* 2023;13:196. 10.3390/jpm13020196.
15. Han C, Ren ZY, Jiang ZH, Luo YF. Cerebral complications after unilateral biportal endoscopic surgery: a case report. *World J Clin Cases.* 2025;13:101444. 10.12998/wjcc.v13.i13.101444.
16. Xie B, Feng X, Huang Z, Cheng Z, Long X, Huang C, et al. Unilateral biportal endoscopy-induced intracranial pneumocephalus as radiographic evidence of raised intracranial pressure resulting from dural tear: a case report. *Front Surg.* 2025;12:1710237. 10.3389/fsurg.2025.1710237.
17. Huang C, Mobbs RJ, Ma A, Cook E. Postoperative confusion, pneumocephalus, and seizure following uniportal endoscopic lumbar discectomy: a case report. *Surg Neurol Int.* 2026;17:214. 10.25259/SNI_1374_2025.
18. Brockmann MA, Groden C. Remote cerebellar hemorrhage: a review. *Cerebellum.* 2006;5:64–8. 10.1080/14734220500521032.
19. Friedman JA, Ecker RD, Piepgras DG, Duke DA. Cerebellar hemorrhage after spinal surgery: report of two cases and literature review. *Neurosurgery.* 2002;50:1361-3; discussion 1363-4. 10.1097/00006123-200206000-00030
20. Suzuki M, Kobayashi T, Miyakoshi N, Abe E, Abe T, Shimada Y. Remote cerebellar hemorrhage following thoracic spinal surgery of an intradural extramedullary tumor: a case report. *J Med Case Rep.* 2015;9:68. 10.1186/s13256-015-0541-8.
21. Numaguchi D, Wada K, Yui M, Tamaki R, Okazaki K. Incidence of remote cerebellar hemorrhage in patients with a dural tear during spinal surgery: a retrospective observational analysis. *Spine Surg Relat Res.* 2019;3:141–5. 10.22603/ssrr.2018-0019.
22. Yu H, Zhao Q, Lv J, Liu J, Zhu B, Chen L, et al. Unintended dural tears during unilateral biportal endoscopic lumbar surgery: incidence and risk factors. *Acta Neurochir (Wien).* 2024;166:95. 10.1007/s00701-024-05965-8.
23. Wang B, He P, Liu X, Wu Z, Xu B. Complications of unilateral biportal endoscopic spinal surgery for lumbar spinal stenosis: a systematic review of the literature and meta-analysis of single-arm studies. *Orthop Surg.* 2023;15:3–15. 10.1111/os.13437.
24. Chen Z, Zhou H, Wang X, Liu Z, Liu W, Luo J. Complications of unilateral biportal endoscopic spinal surgery for lumbar spinal stenosis: a meta-analysis and systematic review. *World Neurosurg.* 2023;170:e371–9. 10.1016/j.wneu.2022.11.019.

25. Liang J, Lian L, Liang S, Zhao H, Shu G, Chao J, et al. Efficacy and complications of unilateral biportal endoscopic spinal surgery for lumbar spinal stenosis: a meta-analysis and systematic review. *World Neurosurg.* 2022;159:e91–102. 10.1016/j.wneu.2021.12.005.
26. Park HJ, Kim SK, Lee SC, Kim W, Han S, Kang SS. Dural tears in percutaneous biportal endoscopic spine surgery: anatomical location and management. *World Neurosurg.* 2020;136:e578–85. 10.1016/j.wneu.2020.01.080.
27. Lee HG, Kang MS, Kim SY, Cho KC, Na YC, Cho JM, et al. Dural injury in unilateral biportal endoscopic spinal surgery. *Global Spine J.* 2021;11:845–51. 10.1177/2192568220941446.
28. Tsutsumimoto T, Yui M, Uehara M, Ohta H, Kosaku H, Misawa H. A prospective study of the incidence and outcomes of incidental dural tears in microendoscopic lumbar decompressive surgery. *Bone Joint J.* 2014;96–B:641–5. 10.1302/0301-620X.96B5.32957.
29. Huang H, Zhu C, Qin H, Deng L, Huang C, Saifi C, et al. Intracranial hemorrhage after spinal surgery: a literature review. *Ann Transl Med.* 2022;10:1141. 10.21037/atm-22-4929.
30. Allouch H, Abu Nahleh K, Mursch K, Shousha M, Alhashash M, Boehm H. Symptomatic intracranial hemorrhage after dural tear in spinal surgery: a series of 10 cases and review of the literature. *World Neurosurg.* 2021;150:e52–65. 10.1016/j.wneu.2021.02.071.

Figures

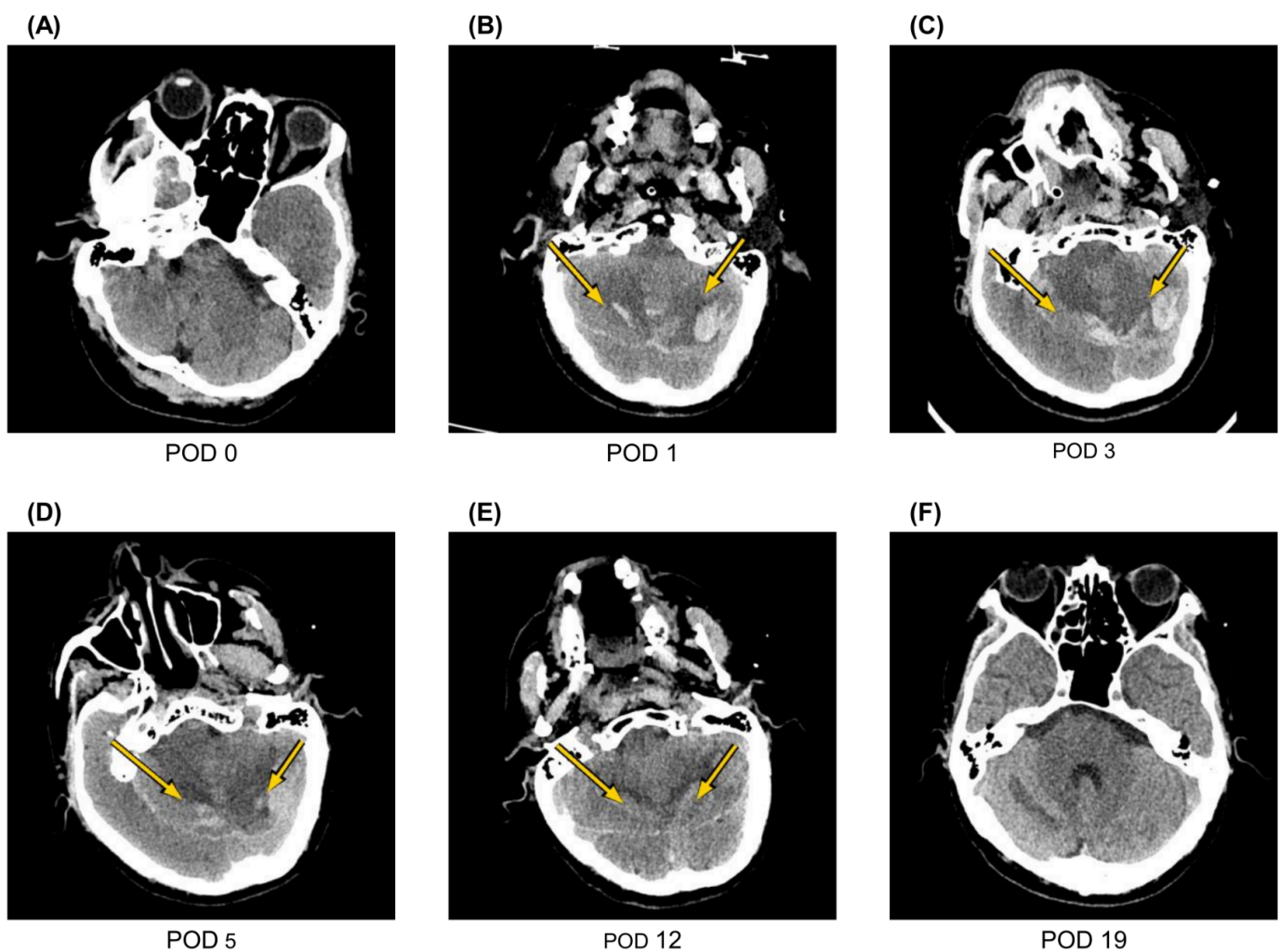


Figure 1

Evolution of remote cerebellar hemorrhage on serial head computed tomography. (A) Immediate postoperative head computed tomography (CT) on postoperative day (POD) 0 showed no definite intracranial hemorrhage. (B) CT on POD 1 demonstrated bilateral cerebellar hemorrhage. (C–F) Serial CT images obtained on POD 3, POD 5, POD 12, and POD 19 showed progressive reduction in the extent and attenuation of the cerebellar hemorrhagic foci, with substantial resolution by POD 19. Yellow arrows indicate the hemorrhagic foci. CT, computed tomography; POD, postoperative day.

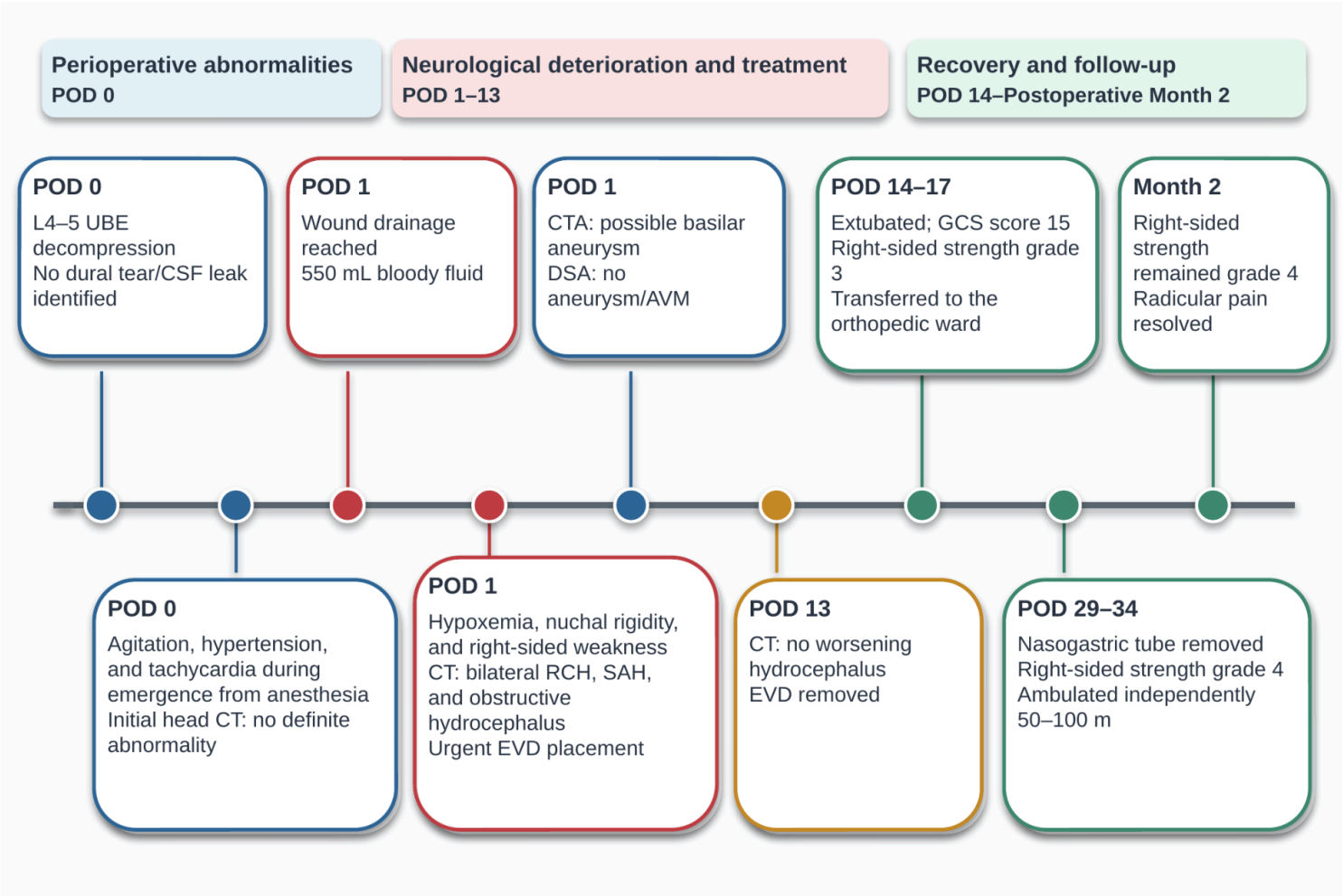


Figure 2

Perioperative clinical course, management, and short-term follow-up. Postoperative day (POD) 0 denotes the day of unilateral biportal endoscopic decompression at L4–5; the timeline is not drawn to scale. UBE, unilateral biportal endoscopy; RCH, remote cerebellar hemorrhage; SAH, subarachnoid hemorrhage; EVD, external ventricular drain; CT, computed tomography; CTA, computed tomography angiography; DSA, digital subtraction angiography; AVM, arteriovenous malformation; GCS, Glasgow Coma Scale.