Case Report

Seizures following cervical laminectomy and lateral mass fusion: case report and review of the literature

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Abstract: Incidental durotomy can occur as a complication of spine surgery, which may potentially result in serious intracranial complications. We report a case of a 72 years old male with significant cervical spinal stenosis from C3 to C5 with spinal cord myelomalacia who underwent a posterior cervical decompression with instrumentation and fusion from C3-C5. An incidental dural tear was encountered during the surgery, with a sudden gush of cerebrospinal fluid (CSF) managed intraoperatively. Unfortunately, he developed generalized tonic-clonic seizures subsequently in the immediate post-operative period. Computerized tomography (CT) scan was urgently done which revealed intracranial pneumocephalus, subarachnoid hemorrhage and a right acute subdural hematoma. This case illustrates the intracranial hemorrhage potential subsequent to iatrogenic dural tear and CSF leak manifested by generalized seizures. The repair of incidental durotomy should be done immediately to decrease the amount of CSF leak and prevent any devastating effects of intracranial hemorrhage. The mechanism of this type of bleeding, risk factors and appropriate management are discussed, along with a review of the literature.

Keywords: Cerebrospinal fluid (CSF); cervical decompression; case report

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Introduction

Spine surgery can result in several complications, including vascular injury, nerve root injury, postoperative epidural hematoma formation, wound infections, spinal cord injury and dural tear (1-3). Incidental durotomy with cerebrospinal fluid (CSF) loss also has been reported after lumbar puncture, spinal anesthesia, myelography, and lumbar drain insertion (4-9). Different treatment options are available to treat durotomies that involve direct intraoperative primary closure, including the use of fibrin glue, fat or muscle grafts (10). Durotomy with a cerebrospinal fluid (CSF) leak can rarely lead to intracranial hemorrhage in the form of subdural hematoma, epidural hematoma, cerebellar hemorrhage, subarachnoid hemorrhage, and supratentorial intraparenchymal hemorrhage (11,12). The exact pathophysiology of this type of bleeding is unknown, but it is assumed that a CSF leak can cause a decrease in intracranial pressure and expansion of subdural spaces that may led to downward displacement of the brain, with stretching and a subsequent tearing of bridging veins hence, SDH formation (13,14). Cerebellar bleeding similarly occurs due to downward displacement of the cerebellum and tearing of cerebellar veins (15,16). We present a unique case of intracranial hemorrhage following an incidental dural tear during posterior cervical spinal surgery.

We present the following case in accordance with the CARE reporting checklist (available at https://dx.doi.org/10.21037/jss-20-642).

Case presentation

A 72-year-old, right-handed male presented with neck pain, numbness and weakness of both hands (greater on the right side) along with walking difficulties. His past medical history was only remarkable for gastroesophageal reflux

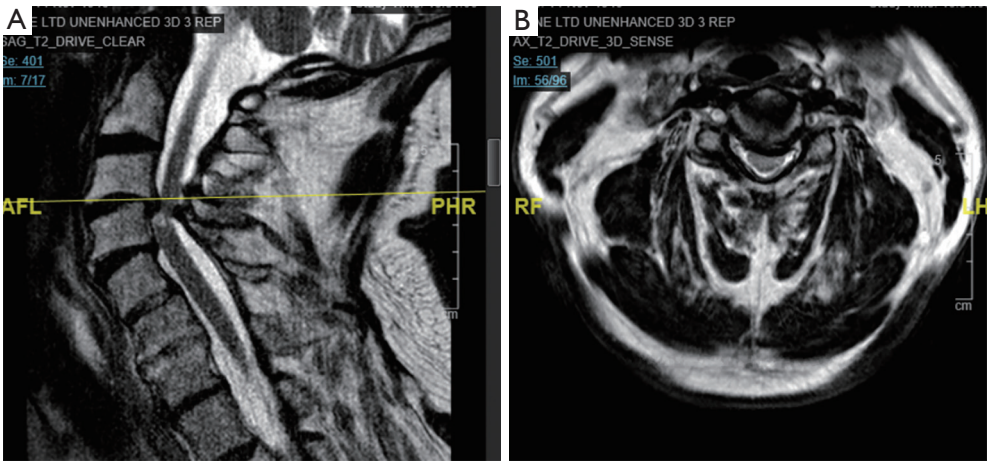

Figure 1 Sagittal T2 MRI (left), and axial T2 MRI (right) of the index level, showing the spinal stenosis and spinal cord myelomalacia.

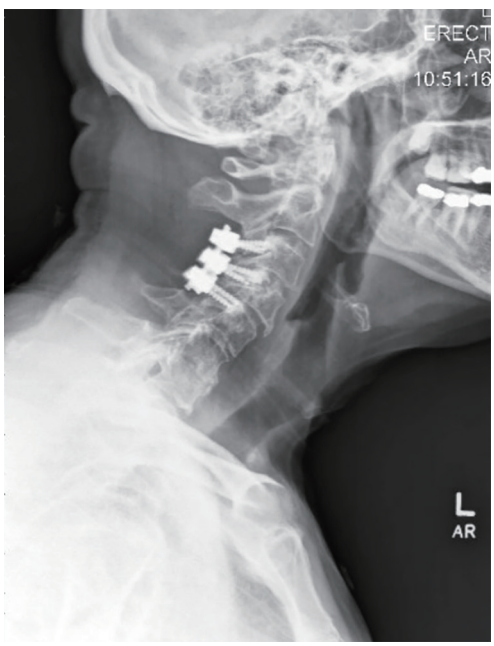

Figure 2 Postoperative lateral cervical X-ray showing the decompression area from C3-5 with lateral mass screw instrumentation.

disease. No history of hypertension or coagulation disorders were documented, and family history was not contributory. He was retired and smoked 1–2 packs of cigarettes per day, in addition to significant alcohol use every day. He was not on any anticoagulant medications.

His neurological exam revealed the mild weakness of intrinsic hand muscles with power +4/5 bilaterally and the right hip flexion weakness with the power of 4/5. Myelopathic signs included the presence of bilateral Hoffman signs and hyperreflexia in all four limbs.

Pre-operative magnetic resonance imaging (MRI) cervical spine scan showed significant stenosis at the level of C3–C5 with spinal cord myelomalacia (*Figure 1*). Laboratory blood tests were all within normal limits, including platelet count, prothrombin time, and activated partial thromboplastin time.

He underwent a posterior cervical decompression with instrumentation and fusion from C3–C5 (*Figure 2*). The patient was placed in a slight reverse Trendelenburg prone position with the head being above the horizontal plane approximately 10 degrees. During the surgery, a dural tear occurred when decompressing the lamina of C5, which resulted in a sudden gush of CSF on the right-side. The CSF leak was managed by immediately applying cottonoids followed by a 5-0 prolene primary closure. 0.5 mL of fibrin glue was applied over the repair area prior to closure. The dural tear repair was tested under direct visualization with an applied Valsalva maneuver at 40 mmHg, and no residual leak was observed at that time. The surgery was completed, and the patient was extubated and brought to the recovery unit. After a few minutes in the recovery room, the patient developed two generalized tonic-clonic seizures that lasted for 15 seconds. As a result, he was intubated and transferred to the Intensive Care Unit. An urgent computerized tomography (CT) scan of the head was ordered. It showed pneumocephalus intracranially in the subarachnoid space of the left Sylvian fissure and basal cisterns, along with an acute subdural hematoma of the midline falx, bilateral tentorial

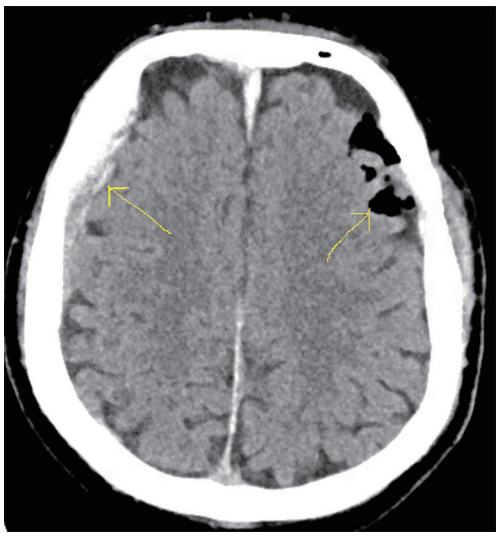

Figure 3 Postoperative axial brain CT scan showing acute subdural hematoma on the right side (left arrow) and pneumocephalus on the left side (right arrow).

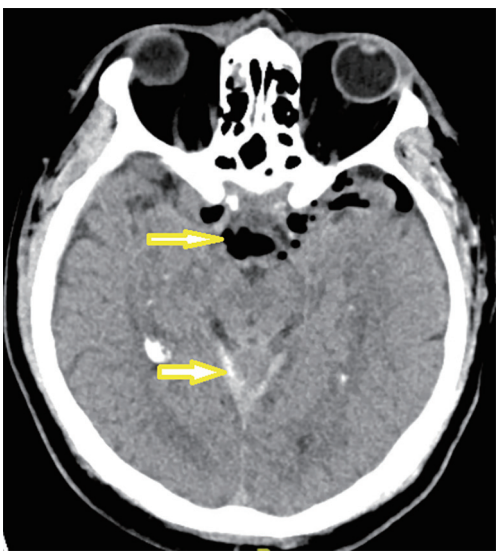

Figure 4 Post-operative axial brain CT scan showing pneumocephalus on basal cisterns (anterior arrow), and acute subdural hematoma on the tentorium leaflet (posterior arrow).

leaflets, right frontoparietal region, and subarachnoid hemorrhage (SAH) in the foli of the cerebellum. Local mass effect from the right frontoparietal area was present without midline shift (*Figures 3,4*). Different aetiologies of subarachnoid hemorrhage were considered like ruptured aneurysms or an arteriovenous malformation, however the bleeding pattern in multiple locations was not consistent with these causes of spontaneous hemorrhages; based on this, we did not obtain a CT angiogram (CTA).

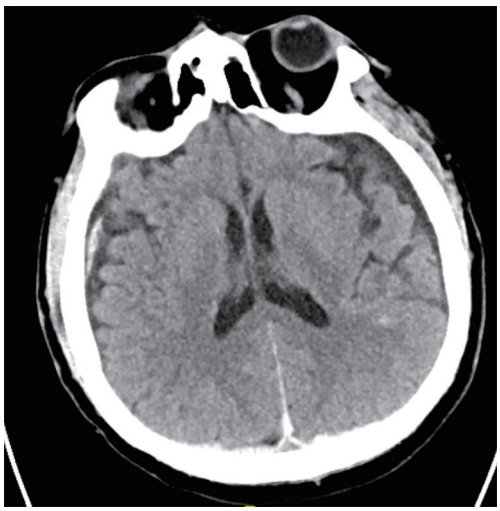

Figure 5 Post-operative axial brain CT scan showing resolution of the pneumocephalus and decreased size of the subdural hematomas.

The patient seizures initially were managed with sedation (Midazolam) and antiepileptics (Phenytoin) in the recovery room. The patient switched over to Levetiracetam in the intensive care unit. After a few days, he was extubated and transferred to the ward. His wound healed very well, without signs of infections, swelling, or CSF leaking from the skin. A Follow-up CT brain scan on a postoperative day five demonstrated resolution of the pneumocephalus and decreased size of the subdural hematomas (*Figure 5*).

He had a full recovery, and he was discharged without further incidents on postoperative day 19. He underwent physiotherapy at an outpatient rehabilitation center following hospital discharge. Three months after discharge, the patient was assessed in the clinic. He reported no further seizures, and his neurological examination showed improvement of his bilateral hand weakness and gait compared to his pre-operative status. No new neurological deficits were noted. All procedures performed in studies involving human participant were in accordance with the ethical standards of the institutional and national research committees and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient, to allow presentation of his case.

Discussion

Dural injuries are a relatively infrequent complication of spine surgery, with an incidence of 4% to 9% (17,18). Multiple etiologies of a CSF leak due to dural tear during surgeries were reported, including direct trauma, excessive nerve root traction, and misplaced instrumentation (19,20). The risk factors that can precipitate this complication include older age, female sex, a previous surgery with scar formation, corrective vertebral osteotomy (CVO), degenerative spondylolisthesis, and radiotherapy that can impair tissue healing (13,21-26). Dural openings are also a part of spinal operations—for example, intradural tumour or lesion.

Acute intraoperative CSF leak after dural tear can rarely lead to the formation of intracranial hematomas. We searched the literature and found 55 cases of intracranial hematomas, including epidural, subdural, SAH, cerebral and cerebellar hematomas following incidental CSF leak during spine surgery (*Table 1*). In most cases, patients present with a persistent headache due to caudal movement of the brain that creates tension on the pain-sensitive dural sinuses (30). In addition to mental status changes, nausea, and vomiting (31). In our case, the patient did not present with any of the milder preceding symptoms. Instead, he presented with a new-onset sudden generalized tonic-clonic seizure that occurred immediately after the surgery.

Different etiologies can induce these intracranial haemorrhages involving previous head trauma, arteriovenous malformations, cerebral atrophy, cranial vault abnormalities, hemorrhagic diatheses, or the presence of cerebral aneurysms (4,7). However, none of these factors were present in our patient, nor were they the source of any of the cases in our literature review (*Table 1*). Instead, our patient was healthy and had no history of hypertension, head trauma or coagulopathy. In addition, dehydration has been described as a known risk factor for intracranial hemorrhage since it reduces brain volume and reduces low intracranial pressure that can increase blood vessel tension hence, making them more vulnerable to rupture (59,60). In our patient, no dehydration was reported throughout the surgery or preoperatively. Also, by positioning the head above the body's horizontal plane can be considered another risk factor for intracranial bleeding. Chadduck reported a cerebellar hemorrhage case in a 59-year-old patient operated on in a sitting position after uncomplicated cervical laminectomy. The elevated position of the head is believed to cause a significant drop in CSF pressure and the development of cerebellar bleeding (27). Our patient was put in a reverse Trendelenburg position with the head being above the horizontal plane by approximately 10 degrees. A slightly head-down positioning during durotomy is recommended in order to lessen brain displacement (9).

Although the exact mechanism of intracranial hemorrhage is unknown, it is postulated that intracranial hematomas development is related to a persistent decrease in intracranial pressure due to loss of CSF volume leading to stretching and then tearing of bridging veins (13,14,61,62). Some authors also suggest that cerebellar hemorrhage can occur due to a drop in CSF pressure that induces downward displacement hence, injuring bridging cerebellar veins (cerebellar sag formation) (15,16). Göbel *et al.* (15) supported this phenomenon, who reported this as a cause of remote cerebellar hemorrhage after spinal surgery. Also, Friedman *et al.* (32) in 2002 reported two cases of cerebellar hemorrhage due to cerebellar sagging caused by dural spinal tear. We believe that the cause of intracranial bleeding in our patient was the sudden loss of a significant volume of CSF through the dural tear that induced the hemorrhage.

A CT-scan will confirm the diagnosis and must be performed as early as possible following the development of any concerning symptoms (63). It may show downward displacement of the brain and cerebellar tonsillar herniation, decrease in the size of the ventricles, meningeal enhancement, dilated epidural veins, or intracranial hemorrhage (13,19,63). In our patient, the CT scan demonstrated pneumocephalus and a moderate-sized subdural hematoma along with subarachnoid hemorrhage. The presence of pneumocephalus might be explained by the 'inverted bottle mechanism' which was reported in previous studies due to the negative pressure created by the CSF leak (39,64). We believe the acute right frontal-parietal subdural hematoma irritated the brain, which propagated the seizures. A significant concern in our case was the potential for further enlargement and increased mass effect of the subdural hematoma, which fortunately did not occur. In our review, we found that the most reported intracranial complications were: cerebellar hemorrhage (63.6%), subdural hematoma (25.4%), and hydrocephalus (20%) followed by intraventricular hemorrhage (5.45%), lobar hemorrhage, subarachnoid hemorrhage, pneumocephalus (9%), and finally cerebellar infarction and epidural hematoma (1.8%) of patients (*Table 2*).

The management of acute SDH after CSF leak varies. Conservative treatment with bed rest, hydration and analgesia are recommended for a small hemorrhage without significant mass effect (32,34). Surgical intervention is often

Table 1 Literature review of intracranial complication following spine surgery durotomy: author, age/sex, procedure, intracranial complication, outcome

Author	Age/ sex	Procedure	Intracranial complications	Outcomes
Chadduck WM (1981) (27)	59M	C3-7 Cervical laminectomy	CBH	Leg's spasticity
Mikawa Y *et al.* (1994) (28)	75M	Redo C1-C2 fusion	CBH + SAH	Died (pneumonia)
Andrews RT *et al.* (1995) (29)	36M	Lumbar scoliosis instrumentation	CBH + HCP	Quadriparesis (decline)
Burkhard PR *et al.* (2000) (30)	71M	Right L5/S1 Laminectomy & discectomy	SDH	Baseline
Lu CH *et al.* (2002) (31)	59F	Redo L5/S1 decompression, instrumentation & fusion	SDH	Baseline
Friedman JA *et al.* (2002) (32)	43M	T9/10 transpedicular discectomy	CBH	Slight residual dysarthria & gait ataxia
Friedman JA *et al.* (2002) (32)	56F	L3/S1 decompression, instrumentation & fusion	CBH	Residual mild dysarthria & ataxia
Hentschel SJ *et al.* (2004) (33)	58F	T5 extradural breast cancer resection & reconstruction	SDH & Pn	Baseline
Kuhn J *et al.* (2005) (34)	46M	Redo L5/S1discectomy	SDH	Residual H/A & concentration problem
Sciubba DM *et al.* (2005) (13)	55F	Redo L3 corpectomy, Instrumentation & fusion	SDH	Baseline
Karaeminogullari O *et al.* (2005) (35)	73F	L3-5 laminectomy + L2-L5 Instrumentation & fusion	CBH + HCP	Mild ataxia
Farag E *et al.* (2005) (36)	43F	L4-S1fusion & reexploration of dural defect	CBH	Diplopia far lateral gaze
Konya D *et al.* (2006) (37)	48F	L3-5 laminectomy & fixation L4/5 discectomy	CBH	Baseline
Ozturk E *et al.* (2006) (38)	23F	thoracolumbar scoliosis Instrumentation & fusion	CBH + TH + Putamen hemorrhage + Pn	Baseline
Chalela JA *et al.* (2006) (39)	62F	L3-5 Laminectomy &fusion	CBH & HCP	Baseline
Zimmerman RM *et al.* (2007) (40)	77M	T11 to S1 instrumentation &fusion	CBH + IVH	Major cognitive deficit. Died 9 months later (pneumonia)
Zimmerman RM *et al.* (2007) (40)	55F	Revision L2 to L4 decompression, instrumentation &fusion	SDH	Baseline
Zimmerman RM *et al.* (2007) (40)	63M	L2 to L5 decompression, instrumentation &fusion	CB SAH	Baseline
Zimmerman RM *et al.* (2007) (40)	64F	L1-sacrum decompression, instrumentation	CBH + HCP	Died (CBH + HCP)
Calisaneller T *et al.* (2007) (41)	67F	L4/S1 decompression & instrumentation	CBH	Baseline
Hashidate H *et al.* (2008) (42)	85F	T5-7 extradural tumor resection	CBH	Near baseline
Beier AD *et al.* (2009) (19)	39F	Right L5/S1 microdiscectomy	Right FP SDH	Baseline
Cevik B *et al.* (2009) (43)	79F	L4-5 decompression	CBH + Pn	Baseline

Table 1 (*continued*)

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Author	Age/ sex	Procedure	Intracranial complications	Outcomes
Cevik B *et al.* (2009) (43)	68F	L4-S1 decompression & instrumentation	CBH	Baseline
Ulivieri S *et al.* (2009) (44)	53F	L4-5 microdiscectomy	CBH	Baseline
Nam TK *et al.* (2009) (45)	61M	L3-5 decompression & discectomy	CBH + IVH + Pn	Mild cerebellar signs
Jung YY *et al.* (2010) (46)	58M	L1-2 discectomy, decompression, instrumentation & fusion	Bilateral FP SDH	Baseline
Gul S *et al.* (2010) (47)	64F	Redo L3-5 decompression, discectomies, & instrumentation	CBH + HCP	Gait ataxia, left foot drop, Bilateral diplopia on far lateral gaze
Nowak R *et al.* (2011) (48)	12F	Thoracic instrumentation	Bifrontal SDH + Pn	Baseline
Fernandez-Jara J *et al.* (2011) (49)	58F	L5/S1 decompression & instrumentation	CBH + CB SAH	Baseline
Hempelmann RG *et al.* (2012) (46)	61F	T1-4 decompression for tumor	CBH	uneventful
Hempelmann RG *et al.* (2012) (50)	69F	L3-4 decompression, instrumentation & fusion	CBH + TOH	Baseline
Hempelmann RG *et al.* (2012) (50)	62F	L2-4 decompression, instrumentation & fusion	CBH + POH	Baseline
You SH *et al.* (2012) (51)	63M	L5-S1 discectomy Redo L3-5 laminectomies &instrumentation	CBH + TH	Baseline
Lee HY *et al.* (2012) (52)	63F	Redo L3-4 fusion	CBH	Baseline
Khalatbari MR *et al.* (2012) (11)	53M	L4-5 discectomy	CBH + HCP	Baseline
Khalatbari MR *et al.* (2012) (11)	75M	L1-5 laminectomy	CBH + HCP	Died (pulmonary complications)
Khalatbari MR *et al.* (2012) (11)	34F	L4-5 discectomy	FP SDH	Baseline
Khalatbari MR *et al.* (2012) (11)	29M	L4-5 discectomy	P EDH	Baseline
Utku U *et al.* (2013) (53)	57M	T12-L5 laminectomy & instrumentation	FT SDH	Baseline
CavanillesWalker JM *et al.* (2013) (54)	65F	L2-5 laminectomy, instrumentation & fusion	CBI + HCP	Dysmetria hands/ fingers & transient vertigo
Choi BW *et al.* (2013) (55)	57F	L4-5 laminectomy, instrumentation & fusion	CBH	Baseline
Kaloostian PE *et al.* (2013) (12)	45M	Anterior & posterior cervical decompression, instrumentation & fusion	CBH	Baseline
Kaloostian PE *et al.* (2013) (12)	55M	Redo lumbar posterior decompression, instrumentation	TP SDH	Baseline
Kaloostian PE *et al.* (2013) (12)	61F	T6–7 transpedicular corpectomy T6–8 laminectomies T3–10 instrumentation & fusion	TP ICH	Baseline
Kaloostian PE *et al.* (2013) (12)	64F	L1-S1 decompression, instrumentation & fusion	CBH + HCP	Died (CBH + HCP)

Table 1 (*continued*)

Table 1 (*continued*)

Author	Age/ sex	Procedure	Intracranial complications	Outcomes
Kaloostian PE *et al.* (2013) (12)	63M	Lumbar Laminectomy, instrumentation & fusion	CB SAH	Baseline
Kaloostian PE *et al.* (2013) (12)	76M	L4 tumor resection & instrumentation & fusion	SDH	Baseline
Kaloostian PE *et al.* (2013) (12)	77M	T11–S1 posterior instrumentation & fusion L-2 pedicle subtraction osteotomy	CB SAH + IVH + HCP	Residual cognitive deficient, decrease mobility, died 9 months later (pneumonia)
Kaloostian PE *et al.* (2013) (12)	81F	L4-5 decompression, instrumentation & fusion	CBH + HCP	Died (CBH + HCP)
Morimoto T *et al.* (2014) (56)	47M	Occipitocervical fusion and C1 posterior arch resection	SDH	Baseline
Haller JM *et al.* (2015) (57)	58F	L3-4 decompression, instrumentation & fusion	CBH	Baseline
Floman Y *et al.* (2015) (58)	75F	L2-5 decompression, instrumentation & fusion	CBH	Baseline
Floman Y *et al.* (2015) (58)	67F	L4-5 decompression, instrumentation & fusion	CBH	Baseline
Floman Y *et al.* (2015) (58)	56M	T10-S1 decompression, instrumentation & fusion	CBH	Baseline

CBH, cerebellar hemorrhage; SDH, subdural hematoma; HCP, hydrocephalus; IVH, intraventricular hemorrhage; SAH, subarachnoid hemorrhage; CBI, cerebellar infarction; EDH, epidural hematoma.

Table 2 Type of intracranial complications

	% (n)
CBH	63.6% (35/55)
SDH	25.4% (14/55)
HCP	20% (11/55)
IVH	5.45% (3/55)
Lobar ICH	9% (5/55)
SAH	9% (5/55)
Pn	9% (5/55)
CBI	1.8% (1/55)
EDH	1.8% (1/55)

CBH, cerebellar hemorrhage; SDH, subdural hematoma; HCP, hydrocephalus; IVH, intraventricular hemorrhage; SAH, subarachnoid hemorrhage; CBI, cerebellar infarction; EDH, epidural hematoma.

required for patients with extensive hemorrhages who have clinically significant neurological deficits (35). Most of the reported SDH cases usually have a benign course with good neurological recovery (33,38). Our literature review found that most patients improved clinically and returned to their baseline (69%), but 18.2% developed neurological symptoms and/or deficits, and 12.7% died (28,29,36,37, 40-58,65,66). The cause of death in most patients was related to pneumonia (57.1%), followed by cerebellar hemorrhage with hydrocephalus in 42.8% of patients (*Tables 3,4*). In the present case, our patient was managed conservatively in the ICU, and his clinical symptoms improved without surgical intervention.

Conclusions

A subdural hematoma is a rare but potentially serious

Table 3 Clinical outcomes

	% (n)
Baseline	69% (38/55)
Residual neurological symptoms and/or deficits	18.2% (10/55)
Death	12.7% (7/55)

Table 4 Causes of death

	% (n)
Pneumonia	57.1% (4/7)
CBH + HCP	42.8% (3/7)

CBH, cerebellar hemorrhage; HCP, hydrocephalus.

complication after CSF leak due to iatrogenic durotomy during spinal surgery. Rapid repair of incidental durotomy should be performed immediately to decrease the volume of CSF leakage, and a Valsalva maneuver should be done to ensure adequate closure to prevent this type of complication. The presence of seizures after spine surgery should alert the physician for postoperative intracranial hemorrhage. A CT scan should be done immediately after the surgery to verify the diagnosis and exclude any other possible structural causes of intracranial bleeding. Management is based on the intracranial radiographic findings and neurological status of the patient.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://dx.doi.org/10.21037/jss-20-642

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/jss-20-642). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in studies involving human participant were in accordance with the ethical standards of the institutional and national research committees and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient, to allow presentation of his case.

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