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The primary aim of *World Journal of Clinical Cases* (WJCC, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

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Delayed neurological dysfunction following posterior laminectomy with lateral mass screw fixation: A case report and review of literature

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Abstract

BACKGROUND

While most complications of cervical surgery are reversible, some, such as symptomatic postoperative spinal epidural hematoma (SEH), which generally occurs within 24 h, are associated with increased morbidity and mortality. Delayed neurological dysfunction is diagnosed in cases when symptoms present > 3 d postoperatively. Owing to its rarity, the risk factors for delayed neurological dysfunction are unclear. Consequently, this condition can result in irreversible neurological deficits and serious consequences. In this paper, we present a case of postoperative SEH that developed three days after hematoma evacuation.

CASE SUMMARY

A 68-year-old man with an American Spinal Injury Association (ASIA) grade C injury was admitted to our hospital with neck pain and tetraplegia following a fall. The C3-C7 posterior laminectomy and the lateral mass screw fixation surgery were performed on the tenth day. Postoperatively, the patient showed no changes in muscle strength or ASIA grade. The patient experienced neck pain and subcutaneous swelling on the third day postoperatively, his muscle strength decreased, and his ASIA score was grade A. Magnetic resonance imaging showed hypointense signals on T1 weighted image (T1WI) and T2WI located behind the epidural space, with spinal cord compression. Emergency surgical intervention for the hematoma was performed 12 h after onset. Although hypoproteinemia and

pleural effusion did not improve in the perioperative period, the patient recovered to ASIA grade C on day 30 after surgery, and was transferred to a functional rehabilitation exercise unit.

CONCLUSION

This case shows that amelioration of low blood albumin and pleural effusion is an important aspect of the perioperative management of cervical surgery. Surgery to relieve the pressure on the spinal cord should be performed as soon as possible to decrease neurological disabilities.

Key Words: Delayed postoperative spinal epidural hematoma; Complications; Spinal surgery; Hypoproteinemia; Risk factor; Case report

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Core Tip: Symptomatic postoperative spinal epidural hematoma (PSEH) is a rare but fatal complication of spinal surgery. Here, we present the case of a patient who underwent cervical laminectomy for cervical spinal cord injury with tetraplegia complicated by PSEH. Hypoproteinemia and pleural effusion can aggravate spinal cord edema and worsen the neurological symptoms. Emergency hematoma evacuation is an effective method to relieve the pressure on the spinal cord. A literature review of similar cases was performed.

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INTRODUCTION

Posterior cervical decompressive laminectomy and lateral mass screw-rod arthrodesis are safe and effective with good long-term efficacy, and have been widely used to manage a variety of cervical spine disorders, including cervical spinal cord injury and multi-segmental cervical spinal canal stenosis[1-4]. Common complications include spinal cord injury, C5 nerve palsy, loss of motion, loss of lordosis, and other complications related to the fixation instruments[4]. Most complications are mild or reversible, and do not require reoperation. Among the complications of this procedure, the incidence of postoperative spinal epidural hematoma (SEH) is extremely low, ranging from only 0.05%-3%[1]. Symptomatic postoperative SEH manifests as surgical site pain, breathing difficulties, and progressive paralysis, and undetected postoperative SEH can lead to severe neurological deficits and even death. Therefore, prompt surgical decompression is usually recommended to prevent irreversible disability[5].

Most postoperative SEH cases are diagnosed within a few days, generally within 24 h after surgery, as initial wound healing is not yet complete[5]. However, postoperative SEH is rarely diagnosed more than three days after surgery; a situation termed delayed postoperative SEH[5,6]. Due to its rarity, little attention has been paid to delayed postoperative SEH following posterior cervical decompressive laminectomy, and literature on the topic is scarce. This lack of knowledge makes patient management difficult, which may increase the risk of resultant irreversible neurological deficits or severe clinical events.

In the present study, we report a case of delayed SEH that developed three days after cervical C3-C7 laminectomy. The patient was promptly diagnosed and underwent urgent evacuation of the hematoma. Fortunately, serious consequences were avoided because of the prompt treatment.

CASE PRESENTATION

Chief complaints

The patient was a 68-year-old man admitted to our institute with a chief complaint of neck pain and tetraplegia following a fall.

History of present illness

Half an hour before presenting to the Emergency Department, the patient fell down and hit his head and neck on a stone while pushing his bicycle on the roadside. He experienced neck pain and could not move his limbs without head, chest, or abdominal pain.

History of past illness

The patient had no history of hypertension, diabetes mellitus, trauma, or tumors. The patient was vegetarian, and his body mass index was 21.91 kg/m².

Personal and family history

The patient had no relevant family medical history.

Physical examination

Upon physical examination, the patient's temperature was 36.2 °C, his blood pressure was 100/65 mmHg, his respiratory rate was 20 breaths per minute, his heart rate was 70 beats per minutes, and he was fully conscious. The patient's conscious sensory function and partial motor function were preserved. Sensory function was also preserved in the anal and perineal areas. The muscle strength in the extremities was as follows: Left upper limb, grade 3; right upper limb, grade 2; internal muscles of the hand, grade 0; left lower limb, grade 3; and right lower limb, grade 2. The injury was graded as a grade C injury according to the American Spinal Injury Association scoring system.

Laboratory examinations

The patient's preoperative coagulation function and platelet count were normal, while other laboratory findings were as follows: Plasma albumin, 34.3 g/L; hemoglobin, 107 g/L; and uric acid, 157.00 µmol/L.

Imaging examinations

Anteroposterior and lateral X-ray images showed a C4, C5 spinous process fracture. Cervical computed tomography revealed a C4 laminar fracture, and magnetic resonance imaging (MRI) revealed spinal stenosis of C3-C7 with spinal cord edema, a compressed spinal cord, and traumatic disc rupture and protrusion of C5/6 and C6/7 (Figure 1).

FINAL DIAGNOSIS

The clinical diagnosis was cervical spinal cord injury with tetraplegia (grade C), C4 laminar fracture, and C4, C5 spinous process fracture.

TREATMENT

Ten days after hospitalization, the patient underwent a total laminectomy and lateral mass screw and rod fixation (C3-C7). The surgery was uneventful, with no excessive bleeding. Two negative pressure drains were placed in each wound. The blood pressure was 105/65 mmHg postoperatively, and the symptoms and physical examination results immediately after surgery were the same as those preoperatively. The two drains were removed three days after surgery as the output gradually decreased. On the same day, approximately 55 h after surgery, the patient experienced neck pain that was relieved in the lateral position. Subsequently, the patient suddenly lost muscle strength in the limb (grade 0). He further presented with subcutaneous swelling of the extremities, severe scrotal edema, and eyelid swelling. Emergency cervical MRI [T1- and T2-weighted imaging (WI)] revealed hypointense signals located behind the epidural space with a compressed spinal cord. Blood tests revealed a plasma albumin level of 24.2 g/L, and B-ultrasonography revealed pleural and pericardial effusion.

Emergency surgery was performed approximately 8 h following symptom onset, and a hematoma was identified between the epidural space and the posterior muscles (Figure 2). No active hemorrhages were observed. After complete evacuation of the hematoma, two drainage tubes were placed as close as possible to the dura mater. Negative vacuum pressure was applied for 10 min after wound closure. The two drainage tubes were removed on days 7 and days 8 postoperatively. The patient's lower limb muscle strength recovered to grade 1 on the second day after hematoma evacuation and to grade 2 on the fourteenth day. Finally, the patient was transferred to the functional rehabilitation department.

OUTCOME AND FOLLOW-UP

On day 30, muscle strength of the left upper and lower limbs and motor weakness recovered to grade 3+, right upper and lower limbs to grade 2+, and internal muscles of the hand to grade 1. The epidural hematoma completely disappeared on MRI, and the central spinal cord revealed high signal intensity on T2WI (Figure 3).

DISCUSSION

Bleeding of the epidural venous plexus is a common cause of delayed SEH. However, the associated risk factors are

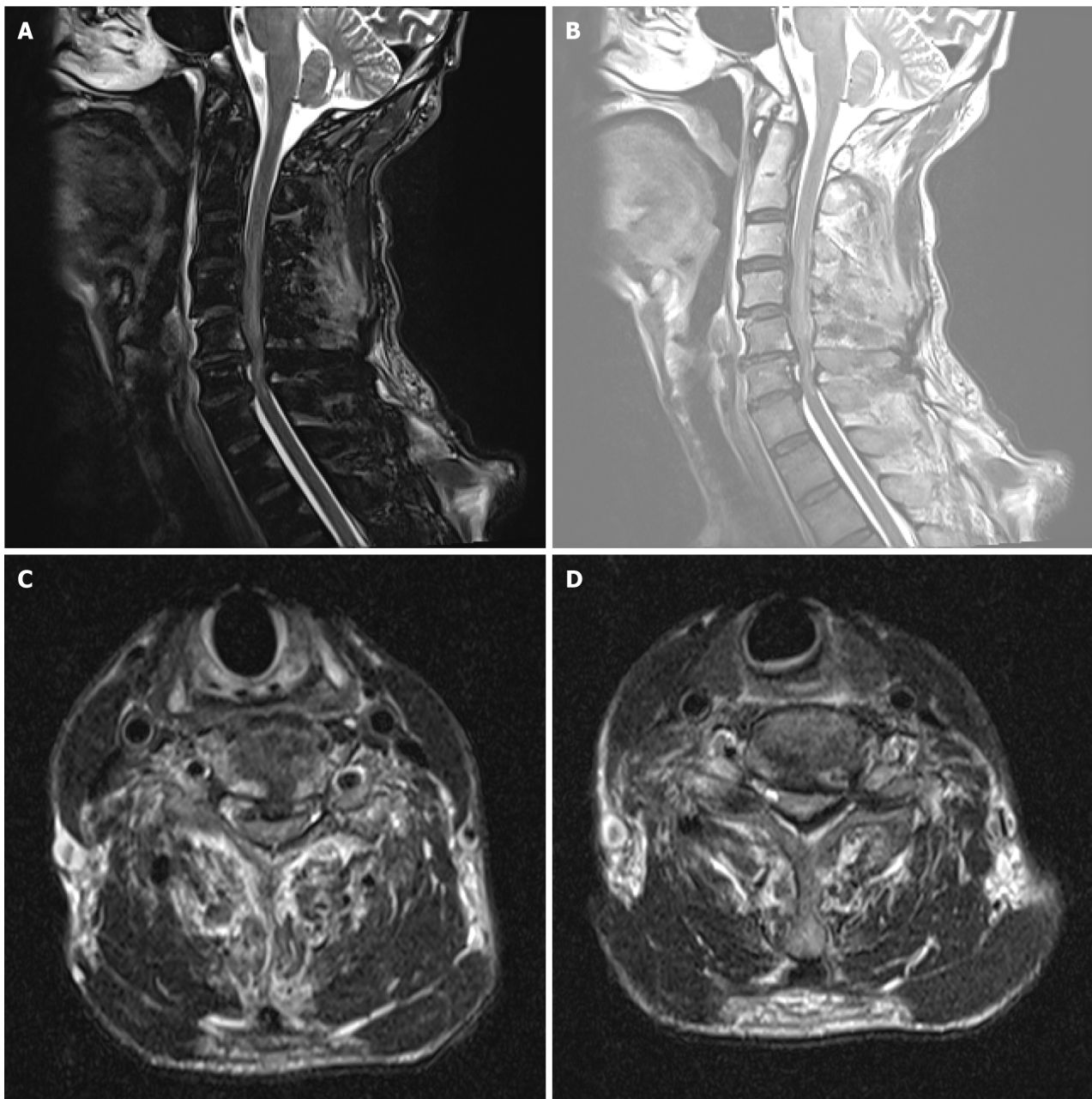


Figure 1 Preoperative magnetic resonance imaging image of the cervical spine showing C3-C7 spinal canal stenosis with spinal cord edema. A: Sagittal T2 weighted imaging (T2WI); B: Sagittal T2WI + fat suppression; C and D: Axial T2WI at the C5/6 (C) and C6/7 (D) levels showing traumatic disc rupture, protrusion and spinal cord compression.

complex, with preoperative risk factors including age > 60 years[7,8], RH-positive blood, hypertension[9], preoperative nonsteroidal anti-inflammatory drugs usage[8], coagulation dysfunction, and vascular anomalies[10]. Furthermore, vertebral hemangioma, multilevel surgery, surgical bleeding > 1000 mL, epidural procedures, and scar tissue have been identified as intraoperative risk factors. In another study, the last numerical value of international normalized ratio > 2.0 within 48 h, the postoperative hemoglobin value < 10 g/dL, the time for ventilator dependence > 48 h, early heparin treatment, and tension-related events such as sneezing, coughing, constipation, and sudden vigorous events were all considered as postoperative risk factors[11]. Other sources of hematoma include bone bleeding, a prepared fusion bed, instrument-irritating vascularized ligamentum flavum[12], and muscle bleeding. Additionally, some studies have reported that the deep cervical artery could be a source of delayed SEH[13,14]. Spinal manipulation therapy can also cause SEH[15]. However, so far, approximately a third of SEH cases have no clear etiology; and are thus classified as spontaneous SEH[16,17]. We reviewed all previously reported cases of SEH, and the characteristics of these cases are summarized in the Table 1.

Coagulation disorders due to anticoagulant use have been indicated as a potential factor related to re-bleeding after surgery[16,18,19]. A study concluded that postoperative hematoma formation was related to anticoagulant therapy[20]. However, the relationship between anticoagulant use, as measured by activated partial thromboplastin time and re-bleeding after surgery, remains controversial. Hypertension is a known risk factor for the development of postoperative

Table 1 Summary of previously reported cases of spinal epidural hematoma both secondary to cervical surgery and spontaneous

Ref.	Country	Sex/age (yr)	Diagnosis	Surgery	Main symptoms	Onset time	Location of bleed	Risk factor	Treatment	Outcome
Chung <i>et al</i> [8], 2020	Malaysia	Female/76	T11/12, stenosis, CSM	Decompression, fusion	Paraparesis	4 d	T11/T12	Unknown	Surgery	Recovery
		Male/53		Laminectomy and LMF C4-C6	Tetraplegia	4 d	C4-C6	Unknown	Surgery	Recovery
Tomii <i>et al</i> [5], 2018	Japan	Male/56	CSM	C4-C6 UODL	Tetraplegia	7 d	C4-C6	Hypertension	Surgery	Recovery
Xu <i>et al</i> [9], 2022	China	Male/86	CDH	C3-C5 ACDF	Tetraplegia	5 d	Behind disc	Unknown	Surgery	Die
Haghnegahdar <i>et al</i> [12], 2016	Iran	Male/29	Cervical locked facet. Subluxation	Poster fixation and fusion	Arm pain numbness	11 yr	C3-C4 ligamentum flavum	Instrument irritation	Surgery	Recovery
Na and Khoo [16], 2023	Singapore	Male/28	Spontaneous SEH	/	Neck pain. Numbness	2 d	C5-6 extradural	Unknown	Non surgery	Recovery
Koga <i>et al</i> [14], 2019	Japan	Male/67	CSM	CPL	Neck pain	26 h	C3-6 epidural	Deep artery	Surgery	Recovery
Liu <i>et al</i> [15], 2021	China	Female/30	/	SMP	Neck pain	3 d	C6-C7	Unknown	Surgery	Recovery
		Male/55	/	SMP	Back pain	1 d	T1-T3	Unknown	Surgery	Recovery
		Male/28	/	SMP	Numbness	4 h	T1-T2	Unknown	Surgery	Recovery
Choi <i>et al</i> [13], 2013	Korea	Male/65	CSM	CPL	Shoulder arm pain	30 months	C5-C7 Epi	Oozed bleeding	Surgery	Recovery
Khan <i>et al</i> [27], 2007	United States	Male/55	CSM	CPL	Spasms	9 d	C3-7 Epi	Unknown	Surgery	Recovery
		Female/58	CSM	CPL	Spasms	2 d	T1-2 Epi	Unknown	Surgery	Recovery
		Female/66	CSM	CPL	Spasms	2 d	C4-5 Epi	Unknown	Surgery	Recovery
Alahmadi <i>et al</i> [20], 2022	Magnolia	Female/67	SSEDH	/	Neck pain and stiffness	2 h	C3-7 Epi	Platelets dysfunction	Surgery	Recovery
Kim and Kuh [21], 2012	Korea	Male/36	CDH	ACDF	Headache hypertension	30 months	C2-T5 Epi	Hypertension	Surgery	Recovery
Morse <i>et al</i> [18], 2007	United States	Male/67	DLS	PLIF	Left chest pain	13 h	C4-S1 Epi	Anticoagulation therapy	Surgery	Recovery
Lee <i>et al</i> [11], 2010	Korea	Male/60	CDH	ACDF	Neck pain	4 h	C1-T4 Epi	Coagulopathy	Surgery	Recovery
Fiani <i>et al</i> [17], 2021	United States	Male/52	SSEH	/	Upper back pain	/	C4-C7 Epi	Coagulopathy. Hypertension. Coagulopathy	Surgery	Recovery
		Female/72	SSEH	/	Neck pain	/	C3-T2 Epi		Surgery	Recovery
Carlhann-Ledermann <i>et al</i> [10], 2020	Switzerland	Female/7	SSEH	/	Neck pain	/	C2-T1 Epi	Vascular malformation VWF decrease	Surgery	Recovery
		Male/4.5	SSEH	/	Neck pain	/	C3-C5 Epi		No	Recovery
Jaweed <i>et al</i> [32], 2020	United States	Male/42	SSEH	/	Neck pain. Paraparesis	/	C3-C4 Epi	Unknown	Surgery	Recovery

Unknown: Hypothesized that epidural venous plexus; UODL: Unilateral open door-type C4 to C6 laminoplasty; Epi: Epidural; ACDF: Anterior cervical discectomy and fusion; BD: Behind the disc; CDH: Cervical disc herniation; CSM: Cervical spondylotic myelopathy; CPL: Cervical posterior laminoforaminotomy; DCA: Deep cervical artery; DLS: Degenerative lumbar stenosis; LMF: Lateral mass fixation; P-O: Postoperation immediately; SHE: Spinal epidural hematoma; SMP: Spinal manipulation therapy; SSEH: Spontaneous spinal epidural hematoma; VWF: Von Willebrand factor.

SEH[21]. However, a study reported that only patients with high postoperative systolic blood pressure had a 1.1-fold higher risk of developing hematomas compared to normal patients[22]. Patients usually present with high blood pressure after surgery due to wound pain. High postoperative blood pressure could lead to high whole blood viscosity that stimulates blood clots and plugs the drainage tube. As such, postoperative blood pressure should be monitored and hypertension should be controlled immediately.

The mechanisms underlying epidural hematomas are not yet completely understood. However, the venous vessel pressure theory may explain the impetus for postoperative SEH. One study previously reported that the epidural venous plexus is directly exposed to intrathoracic pressure, which balances the pressure/volume ratio in relation to the

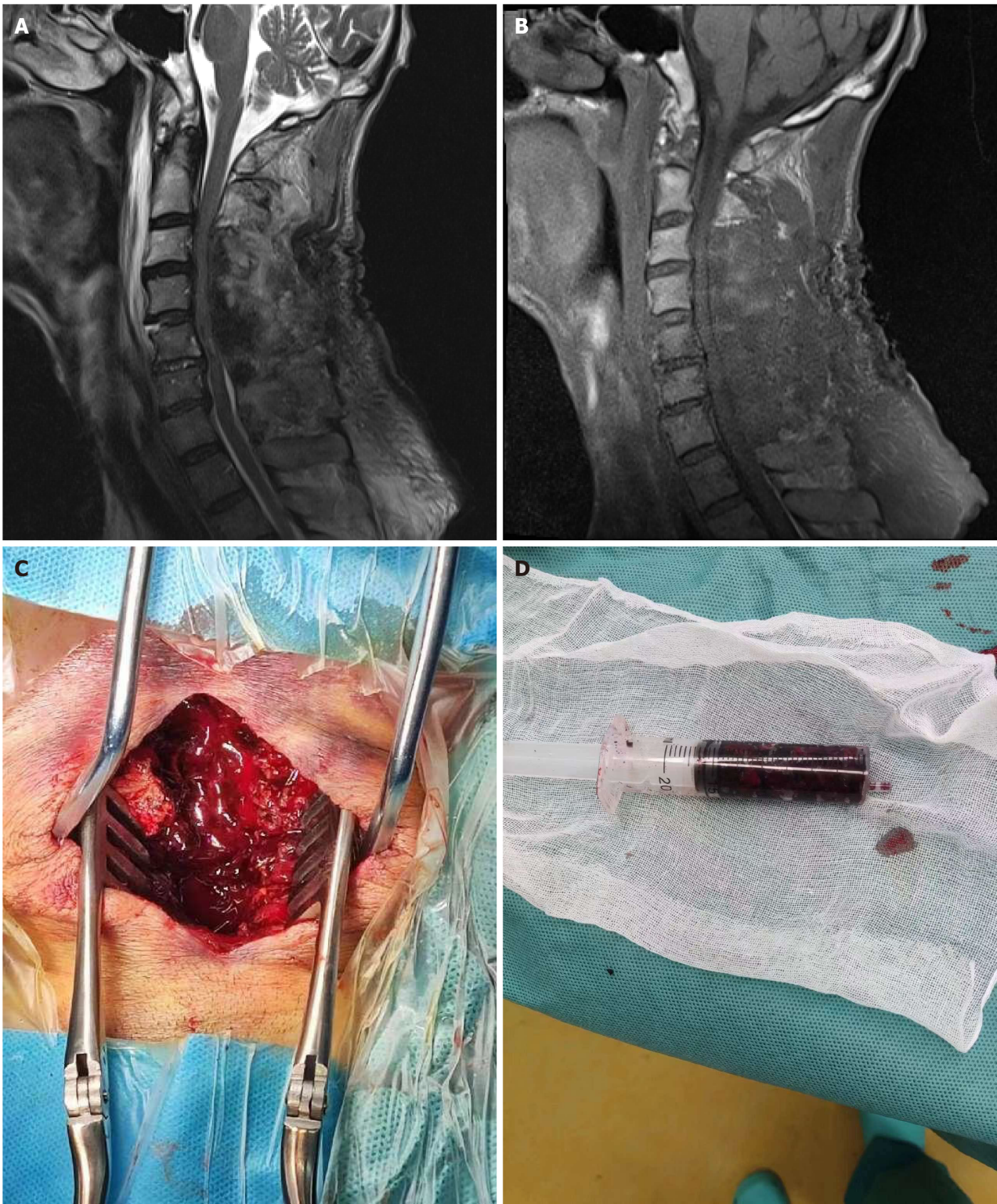


Figure 2 Postoperative magnetic resonance imaging obtained 8 h after symptom onset and the intraoperative view. A: Magnetic resonance imaging (MRI) showing heterogeneous intensity on T2 weighted imaging (T2WI); B: MRI showing an isointense low signal intensity on T1WI with marked indentation on the dural sac; C and D: Intraoperative image showing the spinal epidural hematoma.

intracranial and intrathoracic pressure and volume change[23]. Increased thoracic pressure elevates the intraspinal venous system within the epidural space. High pressure in the epidural venous plexus would predispose a weakened epidural vein to rupture[24]. The patient in the present case presented with limb swelling and pleural effusion after the first operation due to hypoproteinemia. Prior studies have shown that an accumulation of pleural fluid causes gradual increases in thoracic pressure[25], while another study showed that this condition reduces venous return and accelerates massive blood flow reversal from the large caval system into the smaller epidural veins[25,26]. Considering these anatomical prerequisites in association with pleural effusion induced by hypoproteinemia, an increased venous pressure could lead to bleeding and hematoma formation, which extend along the posterior epidural space and compress the

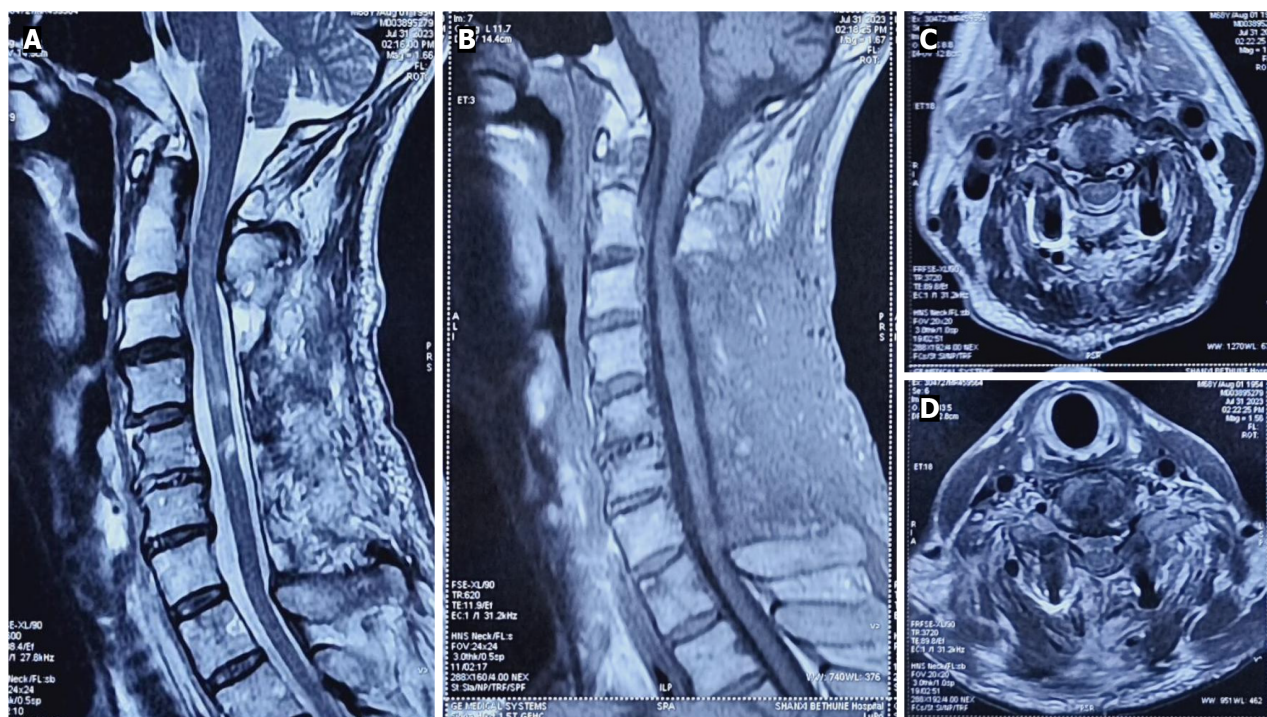


Figure 3 Postoperative magnetic resonance imaging taken 30 d after epidural hematoma elimination. A: Sagittal T2 weighted imaging (T2WI); B: Sagittal T1WI; C and D: Axial T2WI at the C5/6 (C) and C6/7 (D) levels. Epidural hematoma has completely vanished, and the central spinal cord showed high signal at the level of C4-C5 on T2WI.

cervical spinal cord. In our case, neck pain and limb discomfort developed at night, without any predisposing factors such as coughing, straining, sneezing, or hypertension. This nocturnal development suggests that a relationship may exist between chest pressure and hemodynamic changes that may have caused the epidural hematoma.

The present case is unusual due to the presence of a slowly progressive hematoma that accumulated over several days, with mild neck pain and weakness as the primary complaints. Sometimes, the cause of pain or new neurological symptoms recognized immediately after initial surgery are uncertain, due to the retention of blood in the spinal surgery site[27]. In the present case, we found that the postoperative hematoma comprised a clot without blood. We presumed that the hematoma began to develop within a short period on the third postoperative day. MRI is considered as the gold standard diagnostic modality for hematoma[28], as it can demonstrate the specific features of hemorrhage, including an isointense signal on T1WI, a high signal on T2WI within 24 h, and increased signal intensity on both T1WI and T2WI after 24 h. Low-intensity signal images can also be observed in the hyperacute phase of the hematoma. In the present case, a MRI was performed immediately and showed isointense low signal intensity on T1WI and heterogeneous intensity on T2WI, with marked indentation on the dural sac, indicating a hematoma at the surgical site. Additionally, MRI is helpful for measuring the extent, volume, and location of hematoma. Merter and Shibayama[29] previously developed a new classification system for SEH using MRI based on the measurement of the dural sac area and used this system to determine the correlation between the symptoms of postoperative SEH and the compression of the dural sac area. This study indicated that the classification of postoperative SEH based on MRI could predict the clinical status; in other words, a narrower preoperative epidural area would indicate a better clinical outcome in patients with postoperative SEH.

Patients' neurological recovery is related to their preoperative symptoms and the time interval to surgery[30,31]. Prominent symptoms lasting for several hours in cervical postoperative SEH are generally caused by the narrow spinal canal and the low tolerance of cervical neurological structures to the space-occupying effect of a forming hematoma. Therefore, differentiation from ischemic stroke and prompt surgery to clear the hematoma are key to ensure optimal outcomes in postoperative SEH patients[32]. In one related study, Bediwy *et al*[33] concluded that decompression surgery within 8 h could result in good neurological outcomes in patients with SEH. Similarly, Bakker *et al*[34] reported that the preoperative duration of paralysis was the only independent predictor of poor outcome; therefore, it is crucial to determine the neurological deficits and to shorten the interval time to evacuation surgery in patients following posterior cervical spine surgery.

CONCLUSION

Although delayed postoperative SEH following cervical spinal surgery is rare, clinicians should keep this diagnosis in mind to ensure prompt diagnosis and treatment. Meticulous correction of perioperative hypoproteinemia following cervical spine surgery is important to prevent delayed postoperative SEH.

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