Case Report

Remote cerebellar hemorrhage after cervical spinal surgery

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Abstract

Remote cerebellar hemorrhage (RCH) is an unpredictable and rare complication of spinal surgery. We report five cases of RCH following cervical spinal surgery, and summarize another seven similar cases from the literature. Dural opening with cerebrospinal fluid (CSF) hypovolemia seems to be an important factor contributing to RCH following cervical spinal surgery. As other authors have proposed, surgical positioning may be another factor contributing to RCH. RCH is thought to be hemorrhagic venous infarction, resulting from the stretching occlusion of the superior cerebellar vein by the cerebellar sag effect. Either intraoperative CSF loss or a postoperative CSF leak from drainage may cause cerebellar sag, further resulting in RCH. RCH is usually self-limiting, and most patients with RCH have an optimal outcome after conservative treatment. Severe cases that involved surgical intervention because of evidence of brainstem compression or hydrocephalus also had acceptable outcomes, compared to spontaneous CH. It has been suggested that one way to prevent RCH is to avoid extensive perioperative loss of CSF, by paying attention to surgical positioning during spinal surgery. We also underline the importance of early diagnosis and CSF expansion in the early treatment of RCH.

Keywords: cerebellar hemorrhage; cerebrospinal fluid leak; spinal surgery

1. Introduction

Remote cerebellar hemorrhage (RCH) is a rare complication after supratentorial procedures (0.2—4.9%), and even less common following spinal surgery.1,2 As a result of the subtle presentations often seen in cases of RCH, coupled with insufficient knowledge about the disease itself, the correct diagnosis of RCH is usually underestimated. The typical RCH involves blood in the sulci of cerebellar hemispheres and vermis, called a zebra sign on computed tomography (CT).3,4 The precise mechanism of RCH following spinal surgery remains unclear. We report five cases of RCH following cervical spinal surgery and summarize similar cases from the literature. The proposed mechanisms, risk factors, and treatment strategies are discussed.

2. Case reports

2.1. Case 1

A 33-year-old man had C3—5 spinal stenosis with compressive myelopathy. However, following 8 months of rehabilitation, he continued to suffer from foot drop, weakness in grasping, and urine and stool incontinence after undergoing surgery for anterior cervical discectomy and fusion of C3—5. Magnetic resonance imaging (MRI) demonstrated a sequela of myelomalacia originating from a previous spinal...
cord injury at levels C1–4. He underwent further operative procedures in the prone position, including C3–6 laminectomy, posterolateral fusion with screw fixation (PLF-SF), intradural procedure of releasing dentate ligaments (RDL) and duroplasty. However, the patient suffered from postsurgical delayed awakening and generalized seizure attack. Brain CT showed hemorrhage at the bilateral cerebellar hemispheres (CHs) (Fig. 1A), and the patient recovered after conservative treatment.

2.2. Case 2

A 68-year-old man suffered from weakness of the extremities for 3 years. MRI demonstrated C3–6 spinal stenosis

![Noncontrast computed tomography images of unoperated patients](image-url)

Fig. 1. Noncontrast computed tomography images of unoperated patients. (A) Case 1, showing streaky hemorrhage at the bilateral cerebellar hemispheres (CHs) with mild pneumocephalus at the left frontal region. (B) Case 2, showing hemorrhage at the bilateral CHs with obstructive hydrocephalus. (C) Case 3, showing hemorrhage at the bilateral CHs, facing the tentorium, without obstructive hydrocephalus.
with compressive myelopathy. The patient underwent simultaneous anterior and posterior decompression of the cervical spine. In the posterior approach, C2–7 laminectomy, PLF-SF, RDL, and duroplasty were performed in the prone position. Although he awakened from anesthesia, he suffered from further postoperative weakness of the extremities. Considerable CSF drainage volume was noted. We prescribed a megadoses of methylprednisolone and supplied plasma volume expansion with hydroxyethyl starch. However, the patient became drowsy on the second day after the operation. Subsequent brain CT imaging showed hemorrhage at the CHs and mild hydrocephalus (Fig. 1B). We had limited experience concerning the treatment of RCH following spinal surgery, therefore, we undertook a course of conservative management in this case. Fortunately, the patient recovered well.

2.3. Case 3

A 49-year-old man suffered from nuchal pain and numbness of the extremities for 1 year. MRI demonstrated an intramedullary tumor with contrast enhancement at levels C4–7. He underwent several operative procedures in the prone position, including C3–7 laminectomy, PLF-SF, durotomy, and tumor excision (histopathology: ependymoma). He awakened immediately from anesthesia without motor deficit. However, dysarthria developed on the fifth day after the operation. Brain CT showed hemorrhage at the bilateral CHs (Fig. 1C). Thereafter, the patient recovered after conservative treatment.

2.4. Case 4

A 59-year-old female woman had suffered from nuchal pain with radiation to the right forearm for 2 months. MRI revealed ossification of the posterior longitudinal ligament with stenosis at levels C2–4. She underwent further operative procedures, including C2–5 laminectomy, PLF-SF, and durotomy with RDL in the prone position. However, she experienced generalized seizure attack, followed by consciousness deterioration 6 hours after operation. Brain CT showed hemorrhage at the left CH (Fig. 2A). Suboccipital decompressive craniectomy with duroplasty of the posterior fossa was performed immediately. The actual cerebellar swelling was not as severe as we had predicted preoperatively. The patient recovered and the seizure subsided.

2.5. Case 5

A 55-year-old man had C2–4 spinal stenosis with compressive myelopathy after a traffic accident 3 years earlier. The patient was not satisfied with neurological recovery after anterior cervical discectomy and fusion (ACDF) surgery at levels C3–5, even after long-term rehabilitation was completed. MRI demonstrated a sequela of myelomalacia of the previous spinal cord injury at levels C2–4. The patient underwent further operative procedures in the prone position, including C2–5 laminectomy, PLF-SF, RDL, and duroplasty. However, he suffered from dysarthria and consciousness deterioration on the second day after the operation. The drain volume of CSF content was considerable. Brain CT showed hemorrhage at the bilateral CHs with hydrocephalus (Fig. 2B). Suboccipital decompressive craniectomy with duroplasty of the posterior fossa was performed. The patient was alert but he experienced more weakness of the extremities.

3. Discussion

RCH after cervical spinal surgery was first reported by Chadduck in 1981. We have reported five of our own cases and conducted a literature search of RCH after cervical spinal surgery, for a cumulative total of 12 cases (Table 1). The 12 cases consisted of nine men and three women, with an age range of 34–75 years (mean, 54.3 years). All 12 cases had a dural opening. Eleven cases were operated on in the prone position and one in the sitting position. Five cases were operated on for tumor resection, in which the dura was opened widely and extensive loss of CSF may have occurred. As other authors have found, the dural opening with CSF hypovolemia and surgical positioning may have a crucial influence on the occurrence of RCH, particularly following cervical spinal surgery. Many experts believe that RCH is of venous origin. It is believed that bleeding originated in the superior cerebellar vein due to the RCH territory predominantly in the superior cerebellum and the vermis. The clinical presentation may be asymptomatic or as subtle as a mild headache, mimicking intracranial hypotension syndrome. Severe cases can present with dysarthria and consciousness disturbance. As previously mentioned, consciousness disturbance is the most common presentation in the diagnosis of RCH. This may be explained by the presence of intracranial hypotension. Two of our five patients presented with generalized seizure. RCH was detected between 4.5 hours and 120 hours after surgery was completed. RCH can occur not only immediately after the operation, but also as a delayed complication of cervical spinal surgery. Aside from the intraoperative loss of CSF, postoperative CSF leakage as a result of suction drainage also causes RCH in spinal surgery. Among the 12 cases we have described, seven received conservative treatment and the remaining five underwent surgical treatment. Upon review of post-treatment results, eight individuals (66.7%) had a good outcome. Four individuals were alert but remained mildly to moderately disabled, but were capable of competent self-care. One patient who underwent surgery was alert but remained severely disabled, and another surgical patient died due to underlying medical disease. In comparing our experiences to other studies in the literature, the clinical outcome was similar to that observed by Brockmann and seems to be better than those in which spontaneous CH was involved.

In the Monro–Kellie hypothesis, a sudden development of CSF hypovolemia may provoke cerebellar venous congestion, possibly leading to venous rupture with bleeding. Moreover, intraluminal venous pressure may be aggravated by the venous outflow impairment secondary to surgical positioning. The flexion position of the head and neck widens the space between the occipital bone and the cervical spine...
and facilitates placement of a posterior cervical screw system while the patient is in the prone position. However, it may also impair the venous return of the head and neck, further exacerbating the venous congestion of the cerebellum. By contrast, many researchers have proposed that cerebellar sag is the most likely mechanism of RCH.2,3,7,9,17 The bridging veins between the cerebellar tentorium and the superior cerebellum are vulnerable to stretching stress if the cerebellum is displaced away from the tentorium, which is known as cerebellar sag. Cerebellar sag may result in stretching occlusion of the superior cerebellar vein and subsequent hemorrhagic venous infarction.6,7,16,17,19 Cerebellar sag is aggravated by the extensive loss of CSF, and the rapid velocity of CSF loss in a caudal direction that depends on the pressure gradient between the cranial and spinal compartments.17,18 The larger pressure gradient results in a larger CSF shearing force on the cerebellar surface, conceivably leading to vessel rupture or cerebellar sag.

To prevent RCH, the head and neck should be placed as naturally as possible while the patient is in the prone position. The head-down position when opening the dura may reduce the velocity of CSF loss and this potential complication.20 Moreover, intradural refilling is recommended with infusion of normal saline before the dura is closed. The dural opening should be repaired in a watertight manner and the postoperative subfascial drain should be monitored. If the drainage content is primarily CSF or intracranial hypotension is clinically suspected, the drain should be adjusted downward to remove all pressure or halted as soon as possible.1

RCH following cervical spinal surgery is usually self-limiting and limited RCH can be treated conservatively. Such patients should be monitored and followed up by CT scan. However, severe RCH that causes brainstem compression or obstructive hydrocephalus requires immediate surgical decompression.5–9 Suboccipital decompressive craniectomy with duroplasty is indicated for posterior fossa decompression. If the hematoma causes a significant mass effect, it is necessary to perform a hematoma evacuation. The hydrocephalus shows improvement after adequate decompression and reduction of the cerebellar sag. Long-term CSF diversion via a shunt is seldom needed. To prevent exacerbation of the cerebellar sag and its complication, we consider CSF re-expansion.
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ARDS = acute respiratory distress syndrome; CH = cerebellar hemisphere; Cons = consciousness; F = female; M = male; OPLL = ossification of posterior longitudinal ligament; RCH = remote cerebellar hemorrhage.

a Posterior fossa decompression ± external ventricular drain.

b Weakness and spasticity of legs.

c Diplopia and dizziness.

d More weakness of the extremities.
as another important tool in the management of RCH. It has been proposed that plasma volume expansion with immediate infusion of normal saline or Ringer solution may indirectly replace CSF hypovolemia. Additionally, follow-up with antiedematous medications is suggested to prevent secondary injury of the brain after hemorrhage.

The outcome of RCH is significantly correlated with hemorrhage severity, patient age, and the duration between onset of symptoms and radiological diagnosis. Older patient age and RCH with extension to the fourth ventricle or with brainstem compression frequently lead to an unfavorable outcome. However, most patients with RCH had a good outcome after conservative treatment. Severe RCH patients who underwent surgical intervention often had acceptable outcomes that seemed to be better than those outcomes in cases of spontaneous CH.

To a large extent, early diagnosis and treatment result in a favorable outcome. RCH should be considered when a patient experiences unexpected consciousness disturbance or seizure attack following spinal surgery, especially involving a dural opening.

References