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CLINICAL REPORT

Intracranial hemorrhage associated with cerebrospinal fluid drainage during thoraco-abdominal aortic surgery

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Abstract A 69-year-old woman underwent thoraco-abdominal aortic aneurysm repair with cerebrospinal fluid drainage (CSFD). The initial CSF pressure was elevated to approximately 25 cmH_2O, and clear CSF was continuously drained at a rate of 30 ml/h with the drainage level at 10–20 cmH_2O. The CSF became bloody when cardiopulmonary bypass was terminated. The total volume of CSF drained was approximately 300 ml at the conclusion of the 638 min operation. Three hours later, she suffered a series of generalized seizures because of intracranial hemorrhage (ICH). It was suggested that excessive drainage of CSF was associated with ICH. Meticulous control of drainage volume combined with standard pressure-based management may be the key to avoiding these complications.

Keywords Intracranial hemorrhage · Cerebrospinal fluid drainage · Thoraco-abdominal aortic surgery · Bloody cerebrospinal fluid

Introduction

Postoperative paraplegia is a well-recognized complication of the surgical repair of thoraco-abdominal aortic aneurysms (TAAA). Cerebrospinal fluid drainage (CSFD) is widely used as a means of reducing the incidence of postoperative paraplegia [1]. Intracranial hemorrhage (ICH) is one of the most serious neurological complications of CSFD. However, the incidence, risk factors, preventive measures, and management of this complication are poorly defined. We report a case of postoperative ICH after CSFD.

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Case report

A 69-year-old woman was diagnosed with a DeBakey type I acute aortic dissection 16 years before admission. She refused surgical repair at that time. She developed a Debakey type IIIb acute aortic dissection 12 years before admission, and underwent replacement of the aortic aneurysm extending from the ascending aorta to the proximal descending aorta. During postoperative follow-up, the TAAA gradually became larger, and she was admitted for surgical repair. The CT scan showed an aneurysm of 60 mm extending from the descending aorta to the T11 level with a visible artery of Adamkiewicz at the T10 level. Preoperative coronary angiography showed that the left anterior descending artery was totally occluded, and simultaneous coronary artery bypass grafting was therefore planned. She was also noted to have a history of hypertension and an asymptomatic cerebral aneurysm (approximately 6 mm). She was not on any medications except benidipine and metoprolol. The rest of her history and examinations were unremarkable.

On the day before surgery, a CSFD catheter was placed in the subarachnoid space at the L3/L4 intervertebral space using a Tuohy needle, and the catheter tip was positioned at T9. The procedure proceeded smoothly and no complications occurred. The initial CSF pressure was not recorded.

On the day of surgery, the patient was fully awake, ambulating, and no neurological deficits were observed. The induction of anesthesia was smooth without any significant hemodynamic changes. After that, the previously placed CSFD catheter was connected to a closed collecting system. The initial CSF pressure was approximately 25 cmH_2O (the normal CSF pressure is 6–20 cmH_2O). There were no abnormalities in the collecting system. CSF was continuously drained at the rate of 30 ml/h with the drainage level at 10–20 cmH_2O. Following heparin (300 units/kg) administration, routine cardiopulmonary bypass (CPB) was begun. An open proximal anastomosis technique was used during 20 min of deep hypothermic circulatory arrest. The TAAA was replaced with a woven 24 mm four-branched graft with reconstruction of three intercostal arteries and the superior mesenteric artery. Perfusion pressure of the CPB was adequately maintained at 50–70 mmHg except during the circulatory arrest. There was no apparent change in CSFD flow or pressure during 260 min of CPB. When CPB was terminated, the CSF suddenly became bloody. The CSF pressure was still high and CSFD was continued at the same rate of 30 ml/h. The total volume of CSF drained was approximately 300 ml at the conclusion of the 638 min operation. Surgery was completed without any apparent difficulties or complications.

In the immediate postoperative period, the patient's hemodynamic status was somewhat labile with multiple episodes of tachycardia and hypertension. Three hours after conclusion of the surgery, she suffered a series of intractable generalized seizures. Emergency CT scan of the brain showed a subdural hematoma in the right temporal area, an intraparenchymal hemorrhage in the left occipital lobe, a subarachnoid hemorrhage, and brain swelling (Fig. 1). The patient was treated with osmotic diuretics, sedatives, and anticonvulsants. Serial CT scans were obtained 12 and 24 h after onset of the seizure, showing no change in the hemorrhagic lesions. She underwent tracheotomy on postoperative day (POD) 11, and her neurologic condition improved gradually. After vigorous rehabilitation, she was discharged on POD77, with slight disorientation, but was otherwise neurologically intact. Magnetic resonance imaging (MRI) of the brain showed that the cerebral aneurysm was unchanged.

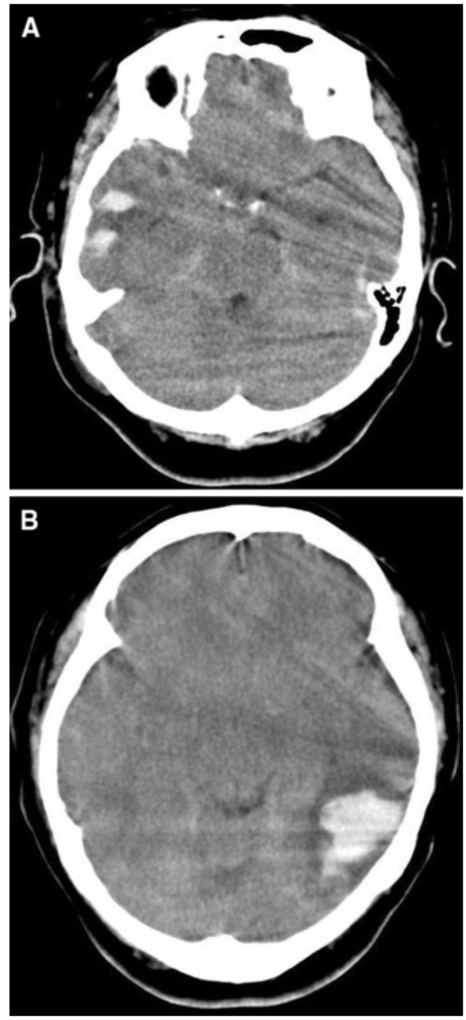

Fig. 1 Emergency CT of the brain showed a subdural hematoma in the right temporal area, an intraparenchymal hemorrhage in the left occipital lobe, a subarachnoid hemorrhage, and brain swelling

Discussion

Various procedures have been used during the repair of TAAA to prevent postoperative paraplegia [2], including distal aortic perfusion, deliberate hypothermia, reimplantation of intercostal arteries, CSFD, intraoperative neurophysiologic monitoring, and pharmacologic agents, but there is no established procedure either alone or in combination that reliably reduces the incidence of this unfortunate complication [2, 3].

The effectiveness of CSFD to protect against spinal cord ischemia has been explained by reduced CSF pressure, leading to improved spinal cord perfusion, because the perfusion pressure is determined by the difference between the pressures of the spinal artery and the CSF. CSFD was first introduced by Blaisdell and Cooley [4], and Coselli et al. reported that CSFD resulted in an 80% reduction in the relative risk of postoperative deficits [5].

Previously reported complications of CSFD include spinal subarachnoid hematoma, spinal epidural hematoma, acute or chronic CSF leakage, ICH, and cerebral herniation [6]. Several incidents of intracranial subdural hematomas after spinal anesthesia have been also reported [7–9], but these complications reported after CSFD were rare [10–13].

One postulated mechanism to explain ICH involves a loss of spinal fluid reducing intracranial pressure, leading to enlargement of the dural venous sinuses, followed by intracranial hypotension which can stretch and rupture large cortical veins crossing the subdural space, and finally resulting in bleeding which occurs in the subdural and also subarachnoid spaces. Stretching and transient occlusion of these veins may increase intraparenchymal venous pressure, and cause intraparenchymal venous hemorrhage [11].

In this case, the exact mechanisms causing the ICH are unknown. There were no significant hemodynamic changes before bloody CSF was noted. Also, it is less likely that a hemorrhagic stroke coincides with both subarachnoid and subdural hemorrhage, although ICH induced by a hemorrhagic infarction could arise either at a site remote from the vascular territory of the ischemic stroke or within it [14].

The volume of CSF drained during the procedure (300 ml over 10 h) may be excessive compared to the normal daily CSF production of 400–600 ml. One can easily postulate that ICH was associated with excessive CSFD in the patient with relatively high CSF pressure, although the initial CSF pressure of 25 cmH_2O in this neurologically intact patient was not considered pathological [15].

Dardik et al. reported 8 patients of CSF drainage-related subdural hematomas (3.5%) in the 230 patients after TAAA repair using CSFD [16]. They also reported that the only factor that was statistically significant and predictive of occurrence of a subdural hematoma was the volume of CSF drained. Of those patients, six patients with an acute presentation of subdural hematoma maintained a CSF pressure at 5 cmH_2O perioperatively.

Wynn et al. reported that bloody CSF was observed in 24 patients (5.0%) of 486 undergoing TAAA repair [17]. Nineteen patients (3.9%) suffered ICH including subdural hematomas, subarachnoid, intraparenchymal, and ventricular hemorrhages. Fourteen patients with ICH had no neurologic deficits. All of the patients had CSF pressure held above 6 mmHg (approximately 8 cmH_2O) during surgery. They reported higher central venous pressures before aortic occlusion, and the volume of drained CSF correlated with the ICH. These reports suggest that excessive CSFD may be a significant contributing factor for the development of postoperative ICH.

No consensus on the optimum CSF pressure or the amount of drainage was established, although many experts maintain CSF pressure between 8 and 13 cmH_2O in this setting [1, 3, 5, 6, 17]. As was seen in this case, if the initial CSF pressure is relatively high, it may be a challenge to determine the optimum CSF pressure. To improve spinal cord perfusion, CSF pressure should be maintained adequately with standard pressure-based management. However, if the volume of CSF drained is presumed to be excessive, adding an empirical volume restriction may be a potential approach to avoid a life-threatening ICH.

Early diagnosis of ICH is another challenge. Precise neurological examinations especially in the early postoperative period are difficult to perform. Anisocoria, seizures, bloody CSF, and a delay in emergence from anesthesia may suggest the occurrence of an ICH. If there are any clinical findings to suggest ICH, an emergent CT scan of the brain could suggest the need for further intervention. Also, CSFD should be immediately stopped to avoid enlargement of the hemorrhage and possible subsequent brain herniation.

In conclusion, the patient with relatively high CSF pressure suffered the ICH associated with excessive CSF drainage during thoraco-abdominal aortic surgery. Early diagnosis, and maintaining adequate CSF pressure with an appropriate drainage volume may play an important role in avoiding these serious complications.

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