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Case Report

Acute epidural hemorrhage following burr-hole irrigation for chronic subdural hematoma: A possible association with the diploic veins ☆,☆☆

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ABSTRACT

A 50-year-old man presented with headache and left hemiparesis. No noticeable preceding head trauma was observed. Computed tomography (CT) scans revealed a compressive chronic subdural hematoma (CSDH). The patient underwent burr-hole irrigation, during which he was considerably restless. In addition, extensive avulsion was found in the parietal dura mater posterior to the burr hole. CT performed immediately after the surgery revealed the emergence of a thick epidural hematoma (EDH) located posterior to the burr-hole. During emergency craniotomy for the EDH, there was no identifiable injury to the dura mater or the meningeal vessels. However, a review of the CT scans confirmed well-developed diploic spaces just above the center of the EDH, with connecting channels between the diploic spaces and extracranial sites. Based on these observations, we assumed that the diploic vein might have caused the EDH. Diploic veins can cause AEDH after burr hole irrigation for CSDH. Appropriate intraoperative sedation and protective irrigation maneuvers can reduce the risk of such AEDH.

Introduction

Chronic subdural hematoma (CSDH) is a common neurosurgical condition associated with significant morbidity and mortality [1]. In general, CSDH is treated by twist-drill or burr-hole craniostomy, although it may be managed by medical treatment [1–3]. Acute epidural hemorrhage (AEDH) is a frequently fatal intracranial hemorrhage that usually develops along with traumatic skull fractures. In contrast, nontraumatic AEDH is a rare entity that can occur in the setting of infection, coagulopathy, vascular malformation of the

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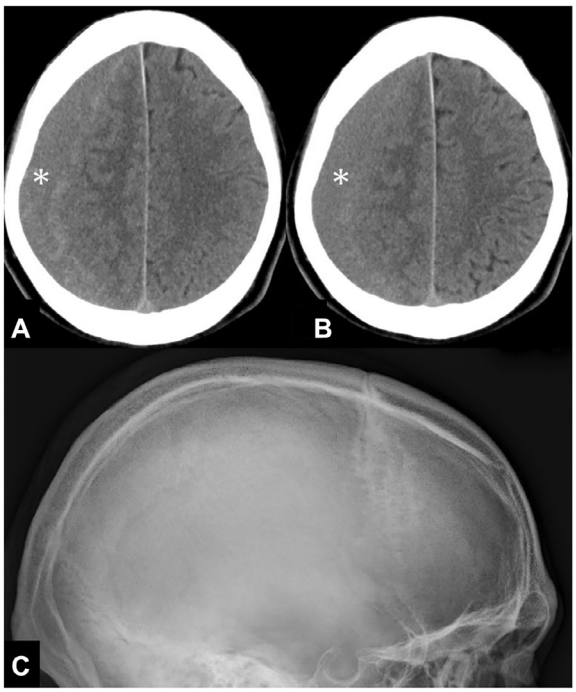

Fig. 1 – Contiguous images of axial computed tomography scans (*A and B*) and lateral view of cranial radiography (*C*) performed at presentation showing an isodense subdural hematoma in the right frontoparietal convexity (*asterisk*). Note that there is no fracture line found in the skull (*C*).

dura mater, hemorrhagic tumors, and hematologic diseases [4]. AEDH following twist-drill or burr-hole craniostomy has rarely been reported [5–9]. However, the mechanisms underlying development of such AEDH remain elusive. The diploic veins (DVs) comprise a distinct venous channel distributed over the skull, confined within the diploe. A previous study documented that areas involving the parietal eminence are predilection sites for well-developed DVs pathways [10].

Here, we present a unique case of AEDH that was assumed to develop after burr-hole irrigation for CSDH in association with the DVs.

Case report

A 50-year-old, previously healthy man presented with headache and left hemiparesis that had not been preceded by head trauma. The patient did not take antiplatelet agents or anticoagulants. He was well-oriented but sustained left hemiparesis of 4/5 on manual muscle test. Blood tests revealed normal findings. Cranial computed tomography (CT) revealed a compressive subdural hematoma, 2.8 cm in thickness, in the right frontoparietal convexity, consistent with CSDH (Fig. 1A and B). Cranial radiography revealed no identifiable fractures (Fig. 1C). The patient underwent emergency burr-hole irrigation under local anesthesia and sedation with intravenous midazolam. During surgery, elaborate irrigation was performed using repeated injections of physiological saline solution into the hematoma cavity. As the patient was considerably restless, additional administration of midazolam was necessary to continue the surgery. Additionally, extensive

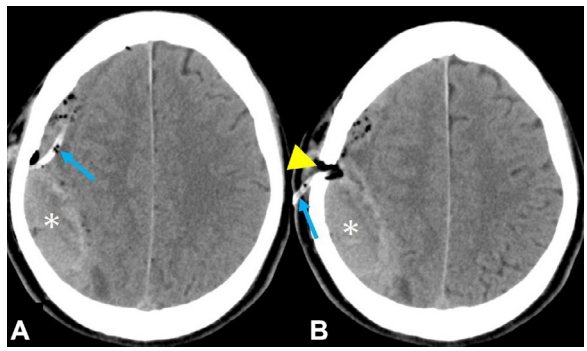

Fig. 2 – Contiguous images of axial computed tomography scans performed immediately after burr-hole irrigation, at the same levels in Fig. 1, showing the presence of biconvex hemorrhage in the right parietal convexity (*asterisk*). The center of the epidural hemorrhage is located 3.5 cm posterior to the posterior margin of the burr-hole (*arrowhead*). *Arrow:* subdural drain tube.

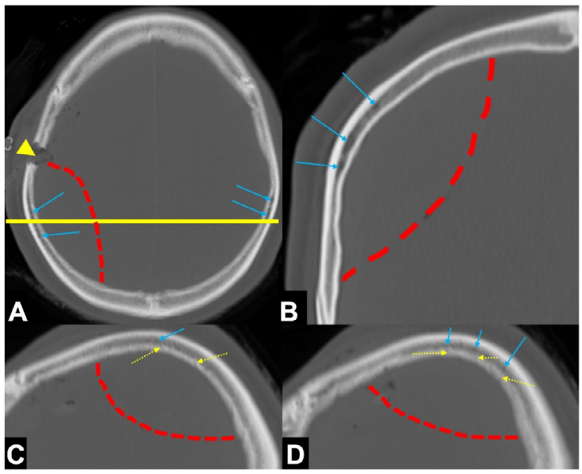

Fig. 3 – Axial (*A*), coronal (*B*), and contiguous sagittal (*C and D*) computed tomography scans at the level of the center of the epidural hemorrhage (*A*, solid line), performed immediately after burr-hole irrigation, showing fine connecting channels (*C and D*, dashed arrows) between the diploic spaces (*a-d*, arrows) and extracranial sites. *Arrowhead:* burr-hole; *Dashed line:* inner (*A and B*) and lower (*C and D*) margins of acute epidural hemorrhage.

avulsion of the dura mater lining the parietal convexity was observed in the posterior area of the burr hole. CT immediately after surgery revealed an epidural hemorrhage (EDH), 2.8 cm in thickness, posterior to the burr-hole. The center of the EDH was located 3.5 cm posterior to the burr-hole (Fig. 2). The patient underwent an emergency craniotomy to evacuate the EDH. During surgery, there was no identifiable injury to the dura mater or meningeal vessels. However, retrospective observation of the CTs scans revealed well-developed diploic spaces just above the center of the EDH, connecting bony channels between the diploic spaces and extracranial sites (Fig. 3). Based on these findings, we assumed that the DVs

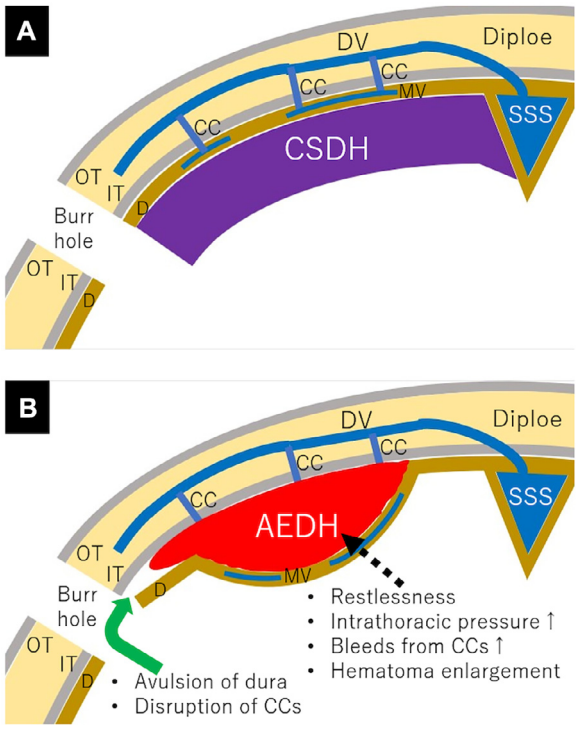

Fig. 4 – Schematic drawings, coronal views, showing a presumable mechanism for development of the present epidural hemorrhage. (*A*) Before development of the hemorrhage, venous channels (*CCs*) connecting between the diploic (*DV*) and meningeal (*MV*) veins were intact. (*B*) Extensive avulsion of the dura mater from the inner table (*IT*) enhanced by intraoperative irrigation maneuvers might disrupt the CCs, resulting in epidural bleeding and formation of acute epidural hemorrhage (*AEDH*). Intraoperative restlessness of the patient due to insufficient sedation and consecutive intermittent increases in the intrathoracic pressure could enhance the bleeding from the CCs through a retrograde increase in pressure in the superior sagittal sinus (*SSS*) and communicating DVs. *CSDH*, chronic subdural hematoma; *D*, dura mater; *OT*, outer table.

might have caused the EDH. The patient was discharged on postoperative day 8 without neurological deficits.

Discussion

AEDH is a well-known traumatic intracranial hemorrhage. However, AEDH caused by the DVs has rarely been documented [11]. In the present case, there was no identifiable skull fracture commonly associated with AEDH. During burr-hole irrigation for CSDH, the dura mater lining the parietal convexity was extensively avulsed in the area posterior to the burr-hole. In addition, during craniotomy for evacuation of the AEDH, no identifiable injury in the dura mater or meningeal vessels was observed. Furthermore, retrospective observation of the patient's CT scans identified well-developed diploic spaces, transmitting the DVs, just above the center of the AEDH, with connecting bony channels between the diploe and the inner surface of the skull. These findings suggested non-traumatic, venous AEDH, rather than common trauma associated, arterial AEDH. Therefore, we assumed that disruption of the fine venous structures transmitting the connecting channels, caused by an avulsion of the dura mater, may have resulted in the development of the AEDH. In addition, this patient was considerably restless during initial burr-hole surgery. Such a condition could cause intermittent increases in intrathoracic pressure, retrograde increase in pressure in the superior sagittal sinus and connecting DVs, and consequent enhancement of epidural bleeding. Furthermore, elaborate irrigation maneuvers made during the burr-hole surgery might have enhanced avulsion of the dura mater, from the water pressure, and resultant epidural bleeding (Fig. 4). Careful observations of physical, radiological, and intraoperative findings can help clinicians diagnose such an infrequent disease and prevent misdiagnosis. Appropriate intraoperative sedation and protective irrigation maneuvers are essential for reducing the risk of AEDH following burr-hole irrigation for CSDH.

In reported patients with AEDHs following twist-drill craniostomy, all epidural hemorrhages developed in the parietal convexity, posterior to the craniostomy site. In contrast, the subdural drains were inserted anterior to the site [5,7,9]. The human dura mater is thought to have inhomogeneous properties and varies in thickness in different calvarial regions [12]. Compared with other calvarial regions, the dura mater in the parietal region may be more likely to avulse due to a force exerted in an inward direction.

Conclusion

Diploic veins can be a cause of AEDH following burr-hole irrigation for CSDH. Appropriate intraoperative sedation and protective irrigation maneuvers can reduce the risk of such AEDH.

Author contributions

All the authors contributed equally to the study.

Ethical Standards

We declare that all procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Declaration of Helsinki and its later amendments.

Patient consent

Written informed consent was obtained from the patient for publication of anonymized data.

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