

Pediatric acute epidural hematoma caused by contrecoup injury: illustrative case

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BACKGROUND Acute epidural hematomas (AEDHs) are formed by injury of the middle meningeal artery or venous sinus with a linear fracture just above these blood vessels. The incidence of AEDH without fracture is low, and the formation of an acute epidural hematoma due to contrecoup injury is even rarer. Here, the authors report a case of pediatric AEDH due to contrecoup injury.

OBSERVATIONS A 6-year-old boy was injured in a traffic accident and was ejected from the car. At admission, he was clearly conscious without obvious neurological deficits. Computed tomography (CT) revealed a small fracture in the right occipital lobe and a thin epidural hematoma in the contralateral left frontal lobe. A CT scan 3 hours later showed an expanded AEDH. Furthermore, the patient presented with progressive disturbance of consciousness. An emergency craniotomy was performed, but no obvious bleeding point or fracture was observed.

LESSONS The source of bleeding in AEDH due to contrecoup injury in the frontal region is thought to be due to microvessel injury in the dura. Anatomical fragility and the amount of energy transferred causing the injury are associated with the AEDH formation due to contrecoup injury; thus, strict management in high-energy trauma is required.

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KEYWORDS contrecoup; acute epidural hematoma; pediatric

Acute epidural hematoma (AEDH) is more common in young people, with most being found between 10 and 20 years of age.¹ It is usually caused by injury to the middle meningeal artery (MMA) or venous sinus with a fracture line directly beneath the bruise, but hematomas are less likely to occur in children due to strong adhesion of the dura to the endoneurial plate, especially in infants under 2 years of age. In addition, the anatomical dural vascular groove is underdeveloped and shallow, and the MMA is not buried in the bone until the age of 2 years, resulting in less damage from fractures.² Although AEDH without fracture is reported to occur in about 10%–20% of cases,³ AEDH without fracture due to contrecoup injury on the opposite side of the bruise is very rare.

In this article, we report a rare case of AEDH in the frontal region caused by a contrecoup injury without fracture in a child, and a good outcome was obtained with surgery.

Illustrative Case

A 6-year-old boy with no abnormalities in birth or development was admitted to our hospital after a car accident. The patient was

riding in the back row on the right side of a standard car. There was no junior seat installed, and the rear-seat window was open. While driving through an intersection, another car crashed into the patient's car from the left side. The car spun, and the patient was thrown from the car through the open window, sustaining injuries. On admission, his consciousness level was 15 points on the Pediatric Glasgow Coma Scale (E4V5M6), blood pressure was 127/72 mm Hg, pulse was 100 beats/min, respiratory rate was 20 breaths/min, and oxygen saturation was 100% in room air. There was a contusion in the right occipital region with mild subcutaneous swelling, which suggested bruising, and multiple abrasions on the extremities and trunk. His vitality was good, his consciousness level was clear, and there were no abnormal neurological findings. Computed tomography (CT) of the head on admission showed a linear fracture of the right occipital bone with slight pneumocephaly directly below (Fig. 1A and B) and a thin epidural hematoma on the contralateral anterior left side. No other traumatic changes were observed in the body. Because the patient was in a stable condition, conservative treatment was performed, and a repeat head CT scan

ABBREVIATIONS AEDH = acute epidural hematoma; CT = computed tomography; MMA = middle meningeal artery.

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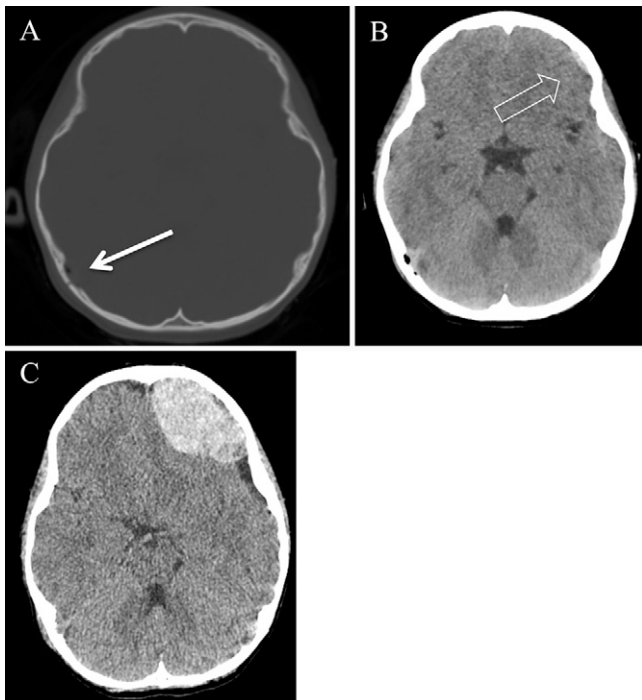


FIG. 1. Head CT studies on admission. **A:** A fracture line and pneumoencephaly were observed in the right occipital region (*arrow*). **B:** A pale acute epidural hematoma was observed in the left frontal region contralateral to the point of impact (*arrow*). **C:** An acute epidural hematoma in the left frontal region was enlarged on CT 3 hours after admission.

was scheduled 3 hours after admission. Head CT showed that the hematoma in the left anterior region was markedly enlarged to a thickness of approximately 40 mm and was pressing on the brain parenchyma; therefore, an emergency craniotomy was performed to remove the hematoma (Fig. 1C). We performed a semicoronal skin incision with the patient under general anesthesia (Fig. 2A) to obtain a complete view of the hematoma, but no obvious fracture line was observed in the frontal region. We performed a rectangular craniotomy with one burr hole on the right parietal side so that the lower edge of the hematoma could be seen, and a dark red epidural hematoma was found (Fig. 2B). After removal of the hematoma, no obvious active bleeding or MMA injury was observed (Fig. 2C). The anterior skull base was also observed, but no obvious bleeding point could be identified (Fig. 2D). The patient was discharged on the 14th day after surgery without any obvious postoperative neurological deficit.

Discussion

Observations

AEDH accounts for 1%–3% of all head trauma cases.⁴ Most cases are associated with linear fractures and damage to the MMA, resulting in the formation of a hematoma just below the contusion point.⁵ However, AEDH without fracture has been reported to account for 10%–20% of all AEDH cases,³ and is slightly more common in children. In most cases, the hematoma forms directly beneath the bruise, and AEDH due to contrecoup injury, as in this case, is very rare. Even in adults, only 27 cases of contrecoup

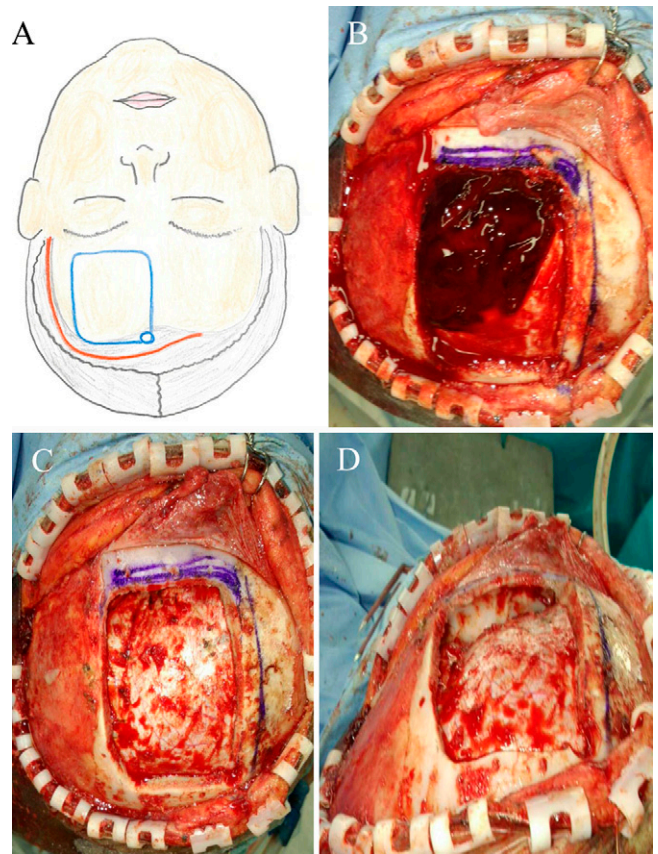


FIG. 2. Intraoperative findings. **A:** Design of the skin incision and the craniotomy. **B:** Acute epidural hematoma without bone fracture. **C:** The source of bleeding was unknown after evacuate hematoma. **D:** There was no obvious bleeding points at the anterior skull base.

AEDH have been reported so far, making it a rare condition.^{1,6,7,8} Unlike coup AEDH, it is more common in women in their 50s to 60s and is characterized by a high frequency of frontal hematoma formation.⁹ Among the 27 cases of contrecoup AEDH reported so far, only three pediatric cases have been reported (Table 1).¹ This is the first case to be described in English.

AEDH due to contrecoup injury occurs even in the absence of fracture when an external force is applied to an anatomically vulnerable area and is thought to occur by two mechanisms that differ depending on the site of the hematoma.¹⁰ After a head contusion, the skull stops rapidly, but, due to inertia, the intracranial tissues continue to move, creating negative pressure between the intracranial tissues and the skull, causing the dura mater to detach.^{11,12} In addition, in children and young adults, the skull is elastic; thus, even if there is no fracture, the skull is distorted by the impact, resulting in dural detachment.^{13,14} In particular, the frontal region is characterized by a tendency for the dura to detach from the endplate of the skull.¹⁵ It has been reported that occipital bruising produces a negative pressure 1.6 times greater than the positive pressure directly below the injured area.^{16,17} It is thought that the large negative pressure applied to the easily detached area damages the cranial-dural intervening vessels, microvessels of the dura mater, and the frontal branch of the MMA, resulting in the formation

TABLE 1. Summary of patient characteristics

Authors & Year	Age (yrs)	Sex	GCS Score*	Impact Site	Site of Contrecoup AEDH	Op†	Injury Vessels	Outcome
Ikeda et al., 1981 ¹⁹	5	F	15	Rt T	Lt SO, bilat O	+	Confluens sinus	GR
Takada et al., 2010 ²¹	9	M	15	Rt O	Lt F	-	Unknown	GR
Present case	6	M	15	Rt O	Lt F	+	Unknown	GR

F = frontal; GR = good recovery; O = occipital; SO = suboccipital; T = temporal.

* At hospitalization.

† Operation for contrecoup AEDH.

of a hematoma.¹⁸ Furthermore, in children who have experienced high-energy trauma, such as in the present case, the dura may be easily detached due to strong skull distortion, and in children with underdeveloped vascular channels, vascular injury may be more likely to occur due to the collision between the dural surface vessels and the skull. The previously reported cases were predominantly adult females with frontal contrecoup AEDH after occipital bruising in 17 (63%) of 27 cases, and 8 (47%) of the 17 cases underwent surgery. Of the eight patients who underwent surgery, two (25%) had MMA damage, one (12.5%) had superior sagittal sinus (SSS) damage, two (25%) had dural microvessel damage, and three (37.5%) had unknown causes. As in the present case, the source of bleeding tended to be difficult to identify.

Ikeda et al.¹⁹ reported occipital contrecoup AEDH due to frontal contusion, and the source of bleeding was a venous sinus commisure. In contrast, the possible mechanisms of surgical bleeding in frontal contrecoup AEDH are as described next.

It has been reported that acute epidural hematomas in children often bleed from the dural veins, interventricular veins, and venous sinuses.²⁰ Although it was difficult to identify the injured vessel in this case, the hematoma gradually increased in size over the course of 3 hours, and bleeding from vessels such as the frontal branch of the MMA was not identified intraoperatively, suggesting that the injury may have been caused by cranial-dural intervening vessels or microvessels of the dura mater. In the previous case reports of contrecoup AEDH, many cases took several hours or more from injury to surgery, suggesting that most cases were due to microvascular injuries. In addition, even though the dura mater and skull are strongly adherent in children, the anatomically fragile lateral portion of the frontal area was subjected to significant negative pressure due to high-energy trauma, and the frontal endplate and dura mater were detached due to strong skull distortion, leading to extensive microvessel damage of the dura mater and hematoma growth that led to surgery. This is thought to be the cause.

On the basis of the CT scan of the patient's head at the time of admission, it was concluded that the risk of requiring surgical treatment was low and that conservative treatment would be sufficient to overcome the problem. However, the injury occurred due to high-energy trauma, and we were able to achieve a good outcome without serious injury by strictly observing the changes in symptoms with the condition of contrecoup AEDH in mind. The outcome was good. It is difficult to evaluate the level of consciousness and neurological findings in children, but it is important to evaluate them frequently, especially in high-energy trauma.

Lessons

In this study, we encountered a case of AEDH in the frontal region caused by contrecoup injury in a child. Contrecoup AEDH can

occur even in the absence of fracture; therefore, it is important to closely monitor the patient and check the imaging over time. In particular, it is very important to keep contrecoup AEDH in mind in children with high-energy trauma because it is difficult to grasp the level of consciousness and neurological findings.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Kajiwara, Furuta, Takeuchi, Morioka. Acquisition of data: Kajiwara, Hashimoto, Furuta, Takeuchi. Analysis and interpretation of data: Hashimoto, Morioka. Drafting the article: Hashimoto, Morioka. Critically revising the article: Kajiwara. Reviewed submitted version of manuscript: Kajiwara, Hashimoto. Approved the final version of the manuscript on behalf of all authors: Kajiwara. Administrative/technical/material support: Kajiwara. Study supervision: Kajiwara.

Supplemental Information

Previous Presentations

Poster presentation at the 44th annual meeting of Japan Society of Neurotraumatology, February 26, 2021, Hyogo, Japan.

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