CASE REPORT

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"Hyperacute" Subdural Hematoma: CT Mimic of Recurrent Episodes of Bleeding in the Setting of Child Abuse

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ABSTRACT: Mixed density extraaxial hematomae on computed tomography (CT) scanning generally represent recurrent episodes of bleeding (chronic subdural hematoma with rebleeding). Hyperacute hemorrhages in which the patient is actively bleeding or has a coagulopathy have also been described as mixed density (1). We report a case of child abuse in a fourteen month old child who presented with a CT scan showing a mixed density subdural hematoma which was originally interpreted as recurrent episodes of hemorrhage, but who had evidence of only acute, active bleeding at surgery and by histologic examination.

There is a proportionally high incidence of subdural hematoma in cases of child abuse, due in part to the increased susceptibility of the immature brain to trauma. Because the mechanism of injury is different for hemorrhage due to hyperacute subdural hematoma (SDH) and that of acute bleeding within a chronic SDH, the distinction between these entities has potentially important legal implications in cases of suspected child abuse. This potential pitfall in interpretation of the CT scan has not to our knowledge been reported in the forensic literature.

KEYWORDS: forensic science, forensic pathology, subdural hematoma, child abuse

Case Report

A 15-month-old white female was apparently beaten, and presented to the emergency department unconscious, with a fixed and maximally dilated, non-reactive left pupil. She had bilateral retinal hemorrhages. Associated injuries immediately identified were a left femur fracture and a left radial fracture.

Unenhanced CT scanning of the head using 5 mm contiguous slices (Fig. 1) revealed significant swelling of the left cerebral hemisphere with left to right shift, and a mixed density left subdural hematoma layering over the entire extent of the convexity. There was compression of the left lateral ventricle, subfalcine herniation and obliteration of the basal cisterns. The subdural hematoma was characterized by areas of increased attenuation relative to the adjacent brain, areas that were hypodense and areas that were nearly isodense with brain (Fig. 2).

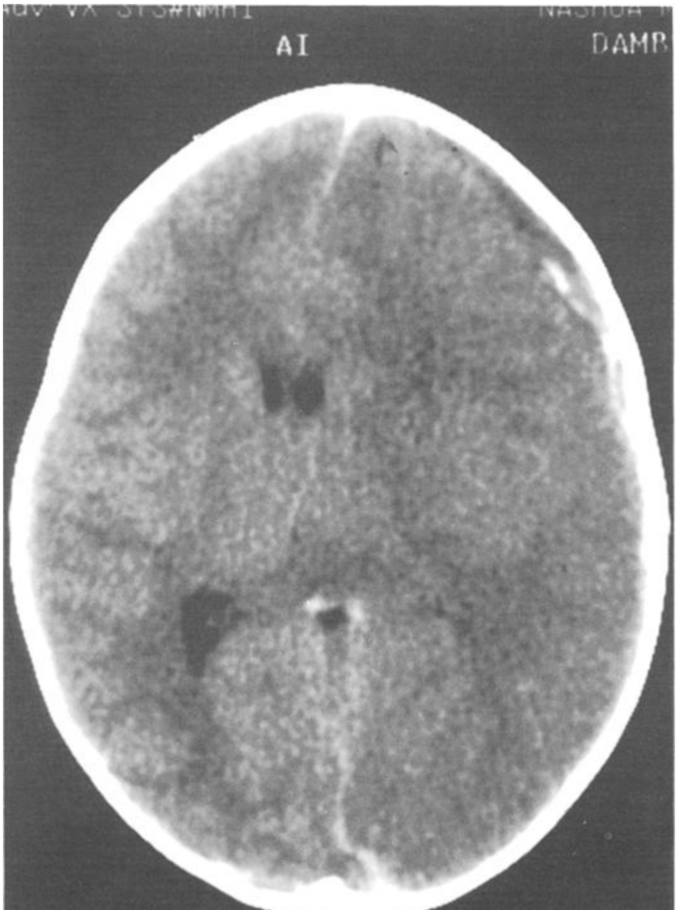

FIG. 1—*CT scan on day of admission revealing mixed density left parietal convexity subdural hematoma with left hemisphere edema and mass effect.*

After 1 g/kg of mannitol, and hyperventilation, she did begin to improve. She opened her eyes once, began to spontaneously

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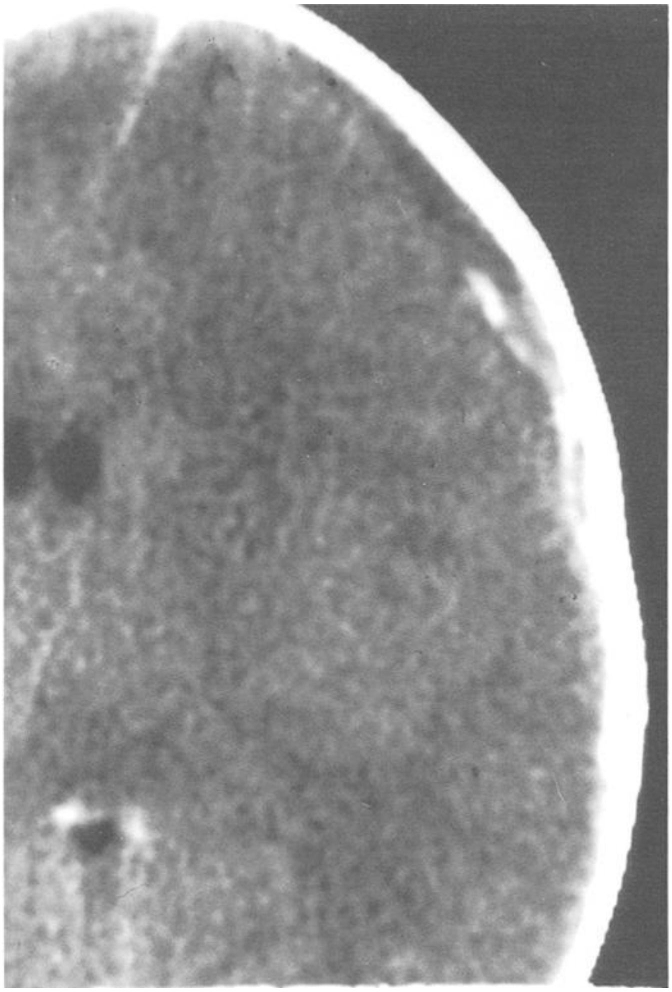

FIG. 2—*Close up of mixed density left subdural hematoma.*

move all extremities, and she exhibited bilateral Babinski responses.

At surgery, through a generous frontotemporal skull flap, about 26 cc of fresh and partially clotted blood extruded through a small stellate dural incision, under great pressure. No membranes were present. A representative sample of this clot was sent to pathology for evaluation. The brain rapidly began to swell, and began to extrude through the dural opening relentlessly. Herniated brain rapidly became ischemic and hemorrhagic. A partial debridement of herniated brain tissue was required to close the dura. The bone flap was not replaced, and the dura was quite tense. The wound was closed.

The patient succumbed on the fifth day of hospitalization, after fulfilling criteria for brain death. Autopsy findings included healing left craniectomy with about 40 cc of adherent subdural blood clot associated with diffuse ischemic cerebral changes. No visible subdural clot membrane formation was noted, not even at the injury periphery. Histological examination of the surgically evacuated clot from craniectomy showed only morphologically intact red blood cells, indicative of acute hemorrhage. Because intervening surgical manipulation limited the usefulness of autopsy examination of the injury, radiological evaluation of the admission CT scan for determination of injury age was requested. Apparent contradiction between radiological and clinico-pathological determination of injury age prompted a review of the radiological literature.

Discussion

On CT scanning, acute intracranial hemorrhages, whether in the epidural, subdural, or subarachnoid spaces (extraaxial) or within the brain parenchyma (intraaxial) are generally of increased density relative to the surrounding brain. The attenuation value of blood is due mainly to hemoglobin. The high CT attenuation values of acute subdural hematomas are related to the hemoglobin concentration and clot retraction which may increase during the first three post-trauma days as clot retraction and hemoconcentration occur (2). Acute hemorrhages may be isodense with brain in anemic patients with hemoglobin values of 8–11%, or even hypodense in patients with extremely low hemoglobin levels (3).

The density of an intracranial hematoma evolves with time. Typically, an acute hyperdense hematoma will gradually become hypodense compared with brain (4). Recurrent hemorrhage into an evolving hematoma will thus appear typically as a mixed or layered density collection.

Greenberg et al. (1), have reported a similar mixed density appearance on CT scanning of 13 patients who had no evidence of prior hemorrhage but, who had acute extraaxial intracranial hematomae that were either actively bleeding, or were in association with a coagulopathy at the time of surgery. They termed this "hyperacute" hematoma. They postulated that the areas of increased density compared to surrounding brain corresponded to clotted blood and the isodense areas represented liquid blood. This appearance mimics that of recurrent hemorrhage on CT scanning and, as in our case, can result in considerable confusion regarding the age of the clot.

With MRI scanning using T1 and T2 weighted imaging, hyperacute, acute, subacute, and chronic hemorrhage have different and distinctive signal appearances. Thus, when there is doubt about whether a patient has had recurrent episodes of bleeding vs. a hyperacute hemorrhage, MRI scanning may be utilized if the patient is clinically stable. A delayed, follow-up CT scan may also be utilized if the clinical situation permits, as a "hyperacute" hemorrhage will become hyperdense where a recurrent hemorrhage will not appreciably change in appearance over at least several days.

Forensic Implications

While the diagnosis of acute or hyperacute SDH implies catastrophic forces acting upon the head and brain, acute subdural hemorrhage within an already established chronic subdural hematoma (rebleed) may occur in the absence of significant trauma; rebleeding within a chronic subdural hematoma is thought to involve the tearing of pathologically fragile neovascular structures within the organizing hematoma (5,6). Thus, the distinction between acute and chronic SDH in the setting of suspected child abuse is of forensic significance as regards both etiology and aging of the injury.

Because this type of injury usually requires emergent evacuation by craniotomy, the preoperative CT scan and the surgeon's intraoperative findings may represent the only record of injury prior to intervening surgical artifact at the time that the case falls under legal scrutiny.

In this paper, we suggest that the forensic interpretation of a single preoperative CT scan for the purposes of dating SDH must be performed with the knowledge of the limitations of such a study, as outlined previously, and that final determination of the nature and chronology of SDH requires direct clinico-pathological correlation.

References

(1) Greenberg J, Dohen WA, Cooper PR. The Hyperacute extraaxial intracranial hematoma: computed tomographic findings and clinical significance. Neurosurgery 1985;17(1):48–56.

(2) Bergstrom M, Ericson K, Levander B, et al. Computed tomography of cranial subdural and epidural hematomas: Variation of attenuation related to time and clinical events such as rebleeding. J Comput Assist Tomogr 1977;1:449–55.

(3) Smith WP, Jr., Batnitzky S, Rengachary SS. Acute isodense subdural hematomas: a problem in anemic patients. AJNR 1981;2:37–40.

(4) Davis KR, Taveras JM, Roberson GH, et al. Some limitations of computed tomography in the diagnosis of neurological diseases. AJR 1976;127:111–23.

(5) Schachenmayr W, Friede RL. The origin of subdural neomembranes. I. Fine structure of the dura-arachnoid interface in man. Am J Pathol 1978;92:53–68.

(6) Schachenmayr W, Friede RL. The origin of subdural neomembranes. II. Fine structure of neomembranes. Am J Pathol 1978;92:69–79.

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