Evaluation of the age of subdural hematomas by computerized tomography

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The computerized tomography (CT) scans of 50 patients with surgically proven subdural hematomas were subdivided into three groups on the basis of the attenuation coefficients of the subdural fluid collections: 28% were more dense, 24% isodense, and 48% less dense than the surrounding brain. The 42 patients with the available data were then subdivided into three groups: acute, subacute, and chronic, according to the time interval between trauma or duration of symptoms and date of CT scanning. Subdural hematomas were found to be hyperdense in 100% of acute patients, isodense in 70% of the subacute group, and hypodense in 76% of the chronic group.

KEY WORDS • subdural hematoma, age of • computerized tomography

SINCE the first report of Ambrose suggesting a possible inaccuracy of computerized tomography (CT) in demonstrating subdural hematomas, further papers have modified this early impression. There is general agreement among the authors that subdural hematomas may present on CT scan in at least three different forms: hematomas that have an attenuation coefficient higher than the surrounding brain (that is, in the range of 35 to 45 EMI units, hyperdense); hematomas of the same density as brain (14 to 24 EMI units, isodense); and hypodense hematomas (4 to 14 EMI units) with lower attenuation coefficients than brain.

The modification of density pattern follows the general rule of change in CT density of extravasated blood with time; although the mechanism is not yet fully understood, it seems to be related to the presence of the protein component of the hemoglobin molecule. Methods to establish the chronological age of subdural hematomas have been controversial in the neurosurgical literature; time relationship with trauma, aspect of the fluid at operation, presence of membranes, and angiographic shape are among the possible criteria of choice.

To verify whether the CT appearance may become a reliable criterion in determining the age and composition of subdural hematomas, we have reviewed the CT scans in 50 patients with such a pathological condition.

Clinical Material and Methods

We reviewed the CT scans done in the x-ray department of the Montreal Neurological Institute in 50 consecutive patients with subdural hematomas who were surgically treated. All the scans were obtained with the EMI head scanner* and the 160 × 160

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in the area of the fluid collection (upper) and displacement of the ventricular system (lower).

Fig. 1. Case 1. Computerized tomography scans showing increased density in the area of the fluid collection (upper) and displacement of the ventricular system (lower).

matrix. In five patients the scan was repeated following intravenous injection of high doses of contrast material (1.9 cc/kg body weight).

There were 15 females and 35 males; 13 patients had bilateral hematomas. The charts of the patients were reviewed and note was taken of the time interval between the date of the possible trauma and the date of the CT examination. In cases in which no history of trauma could be obtained, the interval between the beginning of the symptoms and the date of examination was considered. The patients were then arbitrarily subdivided into three groups: acute, that is, those with an interval of 0 to 7 days; subacute, those with a 7- to 22-day interval; and chronic, those with an interval of more than 22 days.

The CT scans were also subdivided into three groups according to the attenuation coefficients of the fluid collection: hematomas with a higher coefficient than the adjacent brain (35 to 45 EMI units), those of the same density (14 to 24 EMI units), and hematomas less dense (4 to 14 EMI units) than the adjacent brain. Note was also taken in the group of isodense hematomas, of the possible presence of mass effect demonstrated by ventricular displacement.

**Results**

In all, 14 patients had hematomas of increased density (Figs. 1 and 2), 11 of the same density (Fig. 3), and 25 of decreased density (Fig. 4) than the surrounding brain. Bilateral subdural hematomas were, in our series, of the same density on both sides in all patients. Information on the date of previous trauma or beginning of symptoms was available in 42 cases; 11 fell into the acute group, 10 into the subacute group, and 21 into the chronic group (Table 1). When in each of the three groups the CT scans were subdivided on the basis of their attenuation coefficients, it was found that in 100% of patients with acute symptoms the subdural hematomas were of increased density; in 70% of the subacute clinical group they were isodense, while in 76% of the chronic variety they were hypodense (Table 1).

In the subacute group, one hematoma was found to be hyperdense and two were hypodense. In the chronic group, two hematomas were hyperdense and three isodense. In a few cases, an area of increased density within a decreased-density subdural fluid collection was seen (Fig. 5) and it was interpreted as recent bleed into an old subdural hematoma. Mass effect was absent in one of 11 isodense lesions, and was questionable in another patient with bilateral subdural hematomas. In the five patients with isodense subdural hematomas who had intravenous injection of contrast material, evidence of membranes was seen twice; the three negative cases did not have evidence of membranes at surgery.

**TABLE 1**

<p>| Densities seen on CT versus duration of symptoms in 42 patients with subdural hematomas |</p>
<table>
<thead>
<tr>
<th>Duration of Symptoms</th>
<th>Computerized Tomography Scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-7 days</td>
<td>Hyperdense</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>7-22 days</td>
<td>1</td>
</tr>
<tr>
<td>&gt;22 days</td>
<td>2</td>
</tr>
</tbody>
</table>

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Illustrative Cases

Acute Subdural Hematoma

Case 1. This 67-year-old man fell and became unconscious. Skull x-ray film showed fracture of the base of the skull. The CT scan showed extensive increased-density fluid collection over the right hemisphere, displacement of the pineal and right glomus to the left (Fig. 1 upper), and massive displacement of the ventricular system with complete obliteration of the body of the right lateral ventricle (Fig. 1 lower). At operation a large subdural hematoma with fresh, partly clotted blood was found.

Case 2. This 65-year-old woman sustained head injury during a motor vehicle accident. She was admitted the same day and subsequently went into coma. The first CT scan showed increased-density fluid collection on the right (Fig. 2 left). Surgery was postponed because of rapid clinical improvement. A second CT scan 2 weeks later showed reduction in the apparent extent of the increased-density collection (Fig. 2 center). The collection was probably also reducing its attenuation coefficient. Four weeks after trauma, CT scan showed a decreased-density subdural hematoma (Fig. 2 right). At operation oil-like fluid with resolving blood clot was found.

Subacute Subdural Hematoma

Case 3. This 80-year-old woman sustained a head trauma. Two weeks later she was admitted to the hospital complaining of drowsiness, right temporal headache, and confusion for the last 4 days. A CT scan showed severe displacement of the pineal and ventricular system to the left without obvious evidence of any subdural fluid collection (Fig. 3). At operation a very large subdural hematoma of partly liquified clot with the appearance of liquid crank case oil was found extending over the entire right hemisphere. A neomembrane was found over the outer surface of the subdural hematoma. This fluid collection had the same density as brain.

Chronic Subdural Hematoma

Case 4. This 66-year-old man was a chronic alcoholic. He fell and fractured his skull some weeks before admission, but no more information was available. A CT scan showed a very large decreased-density fluid collection.
Fig. 4. Case 4. Computerized tomography scan showing a large area of decreased density over the left hemisphere. The body of the left lateral ventricles (left) and the convolutional sulci (right) are almost completely obliterated.

over the left hemisphere with obliteration of the body of the left lateral ventricle and the convolutional sulci (Fig. 4). At operation, a large fluid collection with the consistency of machine oil and with a thick membrane was removed.

Case 5. This 62-year-old woman had suffered trauma 2 months before. Examination revealed a recent progressive lethargy, confusion, and memory deficit. ACT scan showed a fluid collection of decreased density in its upper part while the lower part was slightly increased in density (Fig. 5). At operation, a chronic subdural hematoma was found with evidence of recent rebleed. The hematoma was evacuated.

Discussion

Review of the literature on subdural hematomas reveals some disagreement about the criteria used to evaluate the age of the subdural hematoma. Authors who have proposed a three-stage classification (acute, subacute, or chronic) on the basis of the time interval between trauma or total duration of symptoms and surgery recognize that there is no sharp dividing line between the three forms. Moreover, in a substantial number of cases there is no history of head injury, while in others, especially in elderly, demented, or alcoholic patients, a temporal basis may not be used as a criterion since no definite information can be obtained on the duration of symptoms, which are often equivocal and start insidiously. Angiographic criteria first proposed by Norman to differentiate between acute and chronic hematomas on the basis of their shape in the anteroposterior projection were partly confirmed and slightly modified by Gilday, et al., while Radcliffe, et al., convincingly showed that the shape of the hematoma depends on the age of the patient more than on the date of the hematoma. Consistent support for this view came from Fogelholm, et al., who state that the hematomas of older patients are thicker than those in a young person as a logical result of the atrophic changes that occur in the aging brain.

Our results show that CT is probably the method of choice in determining the age of the subdural hematomas. All the acute cases showed increased-density collections and this is in agreement with all the published data on the CT appearance of recently extravasated blood. Changes in attenuation coefficients occur at a speed depending on the location of blood. Blood is not visible in the ventricular system 5 to 7 days after hemorrhage, in the subarachnoid spaces 7 to 12 days after, and in the brain parenchyma 15 to 30 days after. Subdural hematomas have been shown to lose their high attenuation coefficient after 2 weeks and become less dense than brain after 4 weeks.

There is some overlap in our clinical subacute and chronic group, and this is most likely due to three main factors: 1) The difficulty in obtaining precise clinical information on the initial traumatic event and the possible difference of speed of resorption of extravasated blood for each patient. 2) Subdural hygromas, that is, subdural collections of cerebrospinal fluid, have a low attenuation coefficient and they cannot be distinguished on CT scans from chronic subdural hematomas. Surgical diagnosis of subdural hygroma is not always easy but it should be
made when the fluid is clear and no membrane formation is found. One of our two subacute patients with a hypodense subdural collection was found to have a hygroma at surgery. A possible rebleed into an old subdural hematoma may be recognized on CT scanning when an area of increased density can be distinguished in contiguity with a well delineated decreased-density collection. When the blood is homogeneously mixed with the preexisting fluid, the result may be an isodense collection. Bilateral subdural hematomas with different attenuation coefficients on each side may be found and would of course create a problem of classification. All of our bilateral subdural hematomas had the same attenuation coefficients on both sides.

In conclusion, we think that despite these limitations CT is the most accurate means to determine the age of subdural hematomas. Although it was not our aim to investigate the accuracy of CT in detecting the presence of subdural hematomas, we think that with the $160 \times 160$ matrix the initial difficulties encountered with the $80 \times 80$ matrix are almost completely overcome. The extent of the lesion as well as the mass effect are better appreciated than on angiography, which is no longer required when a subdural hematoma is shown by CT. Rare entities such as interhemispheric subdural hematomas are easily demonstrated. The only difficult diagnostic problem may be caused by bilateral subacute collections without obvious mass effect and without evidence of membrane enhancement following intravenous injection of contrast material. Differentiation between epidural hematomas and acute subdural hematomas as well as differentiation between arachnoid cyst and chronic subdural hematomas may be difficult. Severe bilateral frontal atrophy is usually recognized because of the persistence of the pattern of the underlying convoluted sulci.

References


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