Dural Calification from the Neurosurgical Point of View

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Summary
A study of dural calcification is presented. The detection by roentgenography of 164 cases of dural calcification among 1,162 neurological and neurosurgical patients represented an incidence of 14%. Such calcification occurred with the greatest frequency in the falx cerebri, tentorium cerebelli and petroclinoid ligament. The main contributing factors and clinical significance of dural calcification were analyzed.
Key words: Intracranial calcification, Dural calcification.

Introduction
Deposits of calcium in the dura mater have been thought to be one example of physiological calcification. Such deposits usually occur in the falx cerebri, tentorium cerebelli and petroclinoid ligament, and rarely in the superior sagittal sinus, diaphragma sellae, interclinoid ligament or other areas of the dura mater. Furthermore, calcification of the dura mater occasionally was observed as a pathological finding either directly or indirectly related to various intracranial lesions. Clinically, however, calcification of the dura mater was not as remarkable as that of the pineal body.
The clinical significance of calcification of the dura mater is discussed herein.

Subjects
A total of 1,162 neurological and neurosurgical patients were subjected to roentgenographic examination of the skull over a period of 1.3 years. Such x-ray photographs revealed calcification of the dura mater, namely, the falx cerebri, tentorium cerebelli, petroclinoid ligament, etc., in 164 of these patients.
The age, sex, site of calcification and clinical diagnoses of these latter patients were analyzed. We then selected five representative cases where the cause of calcification was obvious to a certain degree.

Results
The presence of dural calcification in 164 patients of the authors' series represented an incidence of 14%. Although such calcification was observed in each 10-year age grouping, there was a trend of gradual increase from the 21-30 age grouping on. Also, there was a slightly higher incidence among males than females (Table 1).
The occurrence of calcification of the dura mater by site was in the following descending order: falx cerebri, 10%; tentorium cerebelli, 2%; and petroclinoid ligament, 2%. Calcification was rarely observed in the superior sagittal sinus, diaphragma sellae and interclinoid ligament.
Roentgenography revealed 11 cases displaying calcification in two or more areas of the
The 164 cases were diagnosed as follows: 103 cases of head injury, 18 cases of headache, 14 cases of cerebrovascular diseases, 12 cases of epilepsy, and 17 cases of miscellaneous diseases.

**Table 2.** Incidence and site of dural calcification

<table>
<thead>
<tr>
<th>Age group</th>
<th>Sex</th>
<th>Number of patients</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 5</td>
<td>M</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>6 - 10</td>
<td>M</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>11 - 20</td>
<td>M</td>
<td>10 (2)</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>21 - 30</td>
<td>M</td>
<td>28</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>15 (1)</td>
<td>9</td>
</tr>
<tr>
<td>31 - 40</td>
<td>M</td>
<td>21 (4)</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>6 (1)</td>
<td>5</td>
</tr>
<tr>
<td>41 - 50</td>
<td>M</td>
<td>23 (2)</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>51 - 60</td>
<td>M</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>8 (1)</td>
<td>6</td>
</tr>
<tr>
<td>61 - 70</td>
<td>M</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>71 and over</td>
<td>M</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>M</td>
<td>113 (8)</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>51 (3)</td>
<td>35</td>
</tr>
</tbody>
</table>

Falx = Falx cerebri  
Tento. = Tentorium cerebelli  
Petro. = Petroclinoid ligament  
Diaph. = Diaphragma sellae  
( ) : cases in which x-ray films indicated dural calcification in two or more areas.

dura mater (Table 2). The 164 cases were diagnosed as follows: 103 cases of head injury, 18 cases of headache, 14 cases of cerebrovascular diseases, 12 cases of epilepsy, and 17 cases of miscellaneous diseases.

**Case Reports**

The authors analyzed the causes of calcification in five representative cases (Table 3).

**Case 1** 27-year-old male

He entered hospital with complaints of right hemiparesis, sensory aphasia and headaches. A lateral plain craniogram indicated circular homogenous calcification above the sella turcica (Fig. 1a). An anteroposterior view did not

**Table 3.** Summary of five cases of dural calcification summarized.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Site of calcification</th>
<th>Seen on X-ray examination</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 27y M</td>
<td>Dura of convexity</td>
<td>(+)</td>
<td>Aspergillum</td>
</tr>
<tr>
<td>2. 71y F</td>
<td>Falx cerebri</td>
<td>(+)</td>
<td>Aging</td>
</tr>
<tr>
<td>3. 31y M</td>
<td>Falx cerebri</td>
<td>(+)</td>
<td>Chronic osteomyelitis</td>
</tr>
<tr>
<td>4. 26y M</td>
<td>Falx cerebri</td>
<td>(+)</td>
<td>Skull fracture</td>
</tr>
<tr>
<td>5. 11y M</td>
<td>Dura of convexity</td>
<td>(+)</td>
<td>Epidural abscess</td>
</tr>
</tbody>
</table>

reveal the obvious calcification. A lateral tomogram (Fig. 1b) suggested this calcification to be a superficial lesion of the left temporal lobe.

The patient died without having surgery
performed. In examining the brain, we found a hen's egg-sized tumor extending from the wall of the lateral ventricle to the surface of the temporal lobe (Fig. 1c). Histological examination revealed it to be a benign astrocytoma. Calcification was found in the part of the dura mater that adhered to the surface of the tumor in the temporal lobe.

**Case 2 71-year-old female**

She had been suffering from chronic osteomyelitis of the right frontal bone for about 50 years. A lateral plain craniogram indicated an irregular area of sclerosis of the skull with islands of sequestrated osseous tissue and a skull defect (Fig. 2a). An anteroposterior view (Fig. 2b) also indicated typical linear calcification of the falx.

The scalp wound was debrided, and then granulation tissue surrounding the skull defect, sequestrated osseous tissue and epidural abscess were removed. A postoperative lateral skull film clearly indicated calcification of the dura mater at the site of the skull defect (Fig. 2c).

**Case 3 1-year-old boy**

He was admitted after a stairway fall. A plain craniogram indicated a lineal fracture in the right parietal bone but no calcification of the falx (Fig. 3a). A plain craniogram taken 8 months after the accident indicated linear calcification of the falx (Fig. 3b).

**Case 4 26-year-old male**

This patient was admitted in an unconscious state which had prevailed for 48 hours. At age 20 he suffered fractures of the base of the skull and cranial vault in a railway accident. He then developed acute purulent meningitis following transnasal surgery for cerebrospinal rhinorrhea. On the basis of this past history and EEG findings, he was diagnosed as one of post-traumatic epilepsy.

An x-ray films of the skull indicated spindle-
type calcification of the falx (Fig. 4), rather extensive calcification for such a young patient.

Case 5 11-year-old boy

He exhibited Fröhlich’s syndrome due to a tumor in the third ventricle. A plain craniogram indicated destruction of the posterior clinoid process and upper portion of the dorsum sellae, an increase in digital markings, separation of the coronal suture and irregular intrasellar calcification but no calcification of the dura mater (Fig. 5a).

Endocrinological examination revealed disturbance in the secretion of growth hormones. When right frontal craniotomy was performed, many white plaques were found on the inner surface of the dura mater, and some of these were biopsied. Histological examination revealed fibrous thickening of the dura mater and calcium deposits but there was no osseous tissue (Fig. 5a).

Discussion

Although in this study we considered linear
shadows on skull x-ray films to indicate calcification, there was a possibility that they indicated ossification. As Robertson has pointed out, a narrow thread-like shadow on the midline of the skull does not always indicate calcification but could possibly be created by x-ray techniques involved and also the thickness of the skull. In order to discuss calcification of the dura mater, it is necessary to take into consideration the conditions prevailing at the time the x-rays are taken and the techniques used and then compare these with the histological findings.

Figures on the incidence of calcification of the falx cerebri as presented in literature to date widely vary between 6 and 50%. Bruyn reported that the incidence of calcification of the falx cerebri is higher in patients with endocrine disorders than in those not affected by metabolic diseases (14% as compared to 5%). The incidence of calcification of the falx cerebri in our study was 10%, but as there was only one patient with endocrine disorders, we could not arrive at any conclusion in this regard.

Stanton and Wilkinson, who found calcification of the petroclinoid ligament in 97 of 738 normal skulls, observed that there were 44 cases of calcification of the petroclinoid ligament among 227 skulls with evidence of calcification of the falx, other parts of the dura, or the choroid plexuses. They were of the opinion that their results showed a positive correlation between the frequency of calcification of the petroclinoid ligament and of that elsewhere in the cranial cavity. In our study, only 11 of 164 cases indicated calcification in two or more areas of the dura mater.

It has recently come to be speculated that dural calcification is a natural byproduct of aging. This reasoning was based on the fact that the incidence of calcification of the dura mater shows an increase from the 21-30 age grouping onwards. But there are many aspects which cannot be explained by aging alone, such as the fact that no marked increase in calcification of the dura mater was seen among persons after they had turned 50, while such calcification which cause was not apparent was observed among persons aged 20 or less.

Brain tumors and inflammation (meningitis, osteomyelitis, etc.) have been listed as causes of calcification of the dura mater in previous reports. However, could it not be that their occurrence and that of calcification of the dura mater was merely a coincidence or that they indirectly affected the dura mater after which calcification occurred?

In Cases 1 and 2 outlined herein, however, it was considered that a brain tumor and chronic osteomyelitis, respectively, had directly and locally affected the dura mater and that calcification had occurred as a result of pathological processes. We believe that long-term irritation of lesions is a cause of calcification.

Vetter reported a case in which calcification of the falx cerebri took place within 18 days of the occurrence of a head injury. Case 3 in our series was such a case. The head injury was
thought to be the cause of calcification of the dura mater. However, it was considered that the head injury resulted in localized changes in the falx, such as hemorrhage and contusion, and that these changes had resulted in calcification of the falx.

On the other hand, there is a possibility that detection of calcification of the dura by roentgenography depends entirely on the angle at which the x-ray films are taken, and also that shadows observed on such photos may be false.

As there are no cases in which plain cranigrams taken before and after the occurrence of head injuries are available for comparison, it is thought that in most cases where head injuries and calcification of the dura mater coexist, this is of a coincidental nature.

Bruyn\(^2\) reported that the incidence of calcification of the dura mater was high in cases of endocrine disorders. In Case 5 of our series, the patient who exhibited endocrine disorders, calcium deposits in the dura mater were not revealed in x-ray films but rather were recognized histologically. However, the mechanism by which endocrine disorders bring about calcification of the dura mater is obscure.

A shift in calcification of the dura mater, particularly of the falx, is rarely helpful in diagnosis. Shifts in calcification in the pineal body\(^3\) and the choroid plexuses are more helpful to diagnosis. Calcification of the free edge of the tentorium and the petroclinoid ligament is not clinically significant unless such calcification results from the presence of an adjacent lesion.

**Conclusion**

The detection by roentgenography of 164 cases of dural calcification among 1,162 neurological and neurosurgical patients represented an incidence of 14%. The sites displaying the greatest frequency of such calcification included the falx cerebri, tentorium cerebelli and petroclinoid ligament. The main factors contributing to dural calcification are considered to be aging, long-term irritation of lesions, head injuries and endocrine disorders. It also is considered that dural calcification is not as significant as pineal calcification.

**References**