Contrast Enhancement in Ischaemic Lesions

I. Relationship to Prognosis

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Summary. The contribution of post-enhancement CT scans to the diagnosis of acute cerebral infarction was studied in a consecutive series of infarcts. The timing, density and pattern of enhancement were also analysed for any possible prognostic information, and the incidence of factors of known prognostic significance was estimated on plain and contrast enhanced scans. Enhancement patterns of infarcts were variable and in those cases in which the plain CT diagnosis was equivocal the post-enhancement CT was not infrequently ambiguous also, and occasionally misleading. The outcome of infarcts that enhanced was significantly poorer than in those not showing enhancement, although no relationship between the timing, density or pattern of enhancement and prognosis could be shown. Consideration of the distribution of other factors known to adversely affect prognosis in the two groups does not adequately account for the difference between them suggesting that the contrast medium itself could be the cause of the poorer outcome. There are few positive indications for post-contrast scanning of suspected infarcts and the possible adverse effects of contrast medium should be considered prior to administration.

Key words: CT scanning – Cerebral infarction – Intravenous contrast media

Introduction

The great value of plain computed tomography (CT) in the acute phase of the stroke syndrome is the immediate distinction between high attenuation lesions indicating intracranial haemorrhage, and low attenuation, often in a recognisable vascular distribution, which is characteristic of ischaemic infarction or oedema. When such changes are present and are considered in the clinical context, it is generally not necessary to rescan with intravenous contrast medium. However, the plain CT appearance of ischaemic brain varies with time [1]; some infarcts have a normal appearance on plain CT on the first day after the clinical ictus and again during the phase of macrophage infiltration in the second and third week, but increase abnormally in attenuation following intravenous contrast medium. The reported incidence of this finding on random examination of acute ischaemic lesions varies up to a maximum of 13% [6], but the significance in diagnosis is questionable since it can be strongly argued that a normal scan in the clinical context is sufficiently diagnostic for patient management.

About 5% of stroke syndromes are caused by intracranial tumours, and subdural haematomas may also present in this way. In most cases, distinction is possible on the plain scan but when acute infarcts are associated with considerable intracerebral swelling, they may simulate tumours or inflammatory processes. An assessment of the practical importance of contrast enhancement in establishing the diagnosis in such cases was one objective of the present investigation.

A relationship between post-contrast appearances and prognosis would be a tenable reason for rescanning after intravenous contrast medium; the detection of any such relationship was the second objective of the study.

Material and Methods

All patients with ischaemic infarction without a significant haemorrhagic component scanned at The National Hospital during 1977 and 1978, within four weeks of the onset of a stroke in whom the diagnosis was considered to have been adequately confirmed by further study or by subsequent clinical course, and in whom adequate follow-up clinical information was...
available were, without further selection, included in the study, a total of 201 cases. All were examined using the EMI 5005 body unit, or 1010 head unit with a 160 x 160 matrix. Rescanning immediately after bolus injection of 70 ml of sodium iothalamate containing 420 mgm of iodine/ml (total dose 29.4 g of iodine) was performed in 128 patients. The neuroradiologist's assessment of the diagnosis at the time of reporting the study was noted. Enhancement was assessed visually and a descriptive classification was adopted depending on its relation to the ischaemic lesion. Attenuation values were measured in the apparently nonenhancing and in a sample of enhancing middle cerebral infarcts on both the plain scans and those after contrast medium. Delayed scans were performed in six cases to show the course of, and any change in the enhancement pattern with time after contrast injection. Serial scans which could show any time-related evolution of enhancement patterns in individual cases were available in 37 cases (94 scans).

The size of the lesion was estimated on the plain scan by measuring on hard copy (polaroid or transparency) the longest dimension and multiplying by the greatest width at right angles to give an area. This was corrected for the minification of the method of display and multiplied by the depth of the lesion calculated by the number and depth of contiguous sections in which it was seen. This gave the volume of the cuboid containing the lesion and represented the maximum possible size of a lesion having the dimensions measured. A few post-infarction cysts which came to autopsy soon after a scan were measured by fluid replacement and were shown to contain approximately half of the volume calculated as described; an arbitrary estimate of the size was therefore made by halving the volume of the cuboid. Despite difficulties in making a more accurate assessment of an irregular lesion, it was considered better to use such a standard measured approximation for all cases than to merely grade by eye.

The clinical records were reviewed without knowledge of CT findings and on the basis of the difference between the initial disability and the final disability after stabilisation, the patients were divided into three categories: markedly improved, improved, and little or no improvement, or deterioration.

These groups were correlated with the presence and pattern of enhancement. In the patients with scans taken after the acute phase, the residual volume of low attenuation was compared with that on the initial scan and also correlated with enhancement.

Other factors which could influence prognosis were studied including the position and size of the infarcts, any brain swelling and its extent, the degree of any hypertension or manifest cardiac or vascular disease or conditions predisposing to it. All other investigations and the effects of any therapy were also assessed and a more detailed account of the clinical aspects of some of these cases has been reported elsewhere [5, 7].

**Table 1. Plain CT**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Not given contrast</th>
<th>Contrast given no enhancement</th>
<th>Contrast given enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low attenuation + mass effect</td>
<td>52</td>
<td>13</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>Low attenuation + no mass effect</td>
<td>122</td>
<td>42</td>
<td>41</td>
<td>39</td>
</tr>
<tr>
<td>Mass effect only</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Normal</td>
<td>27</td>
<td>18</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>201</td>
<td>73</td>
<td>59</td>
<td>69</td>
</tr>
</tbody>
</table>

Well-defined low attenuation oedema spreading through the white matter is shown to a variable degree with many tumours and abscesses, but is much less frequent with infarction; considered together with the clinical presentation, it is a useful feature for distinguishing these conditions.

Several patterns of enhancement occur with infarction (Fig. 1) and some of these may simulate other lesions. In the presence of mass effect, patchy enhancement or irregular ring enhancement may simulate a glioma or metastasis, and a more even ring enhancement may be mistaken for an abscess or vice versa. In this study, of the 128 cases given contrast medium, 110 were correctly diagnosed, 10 cases were not distinguished from tumour on the initial CT (Fig. 2) and a diagnosis of encephalitis was considered in two others; in three cases, no opinion was expressed. Over the same period, three tumours, all gliomas, were diagnosed as infarcts on enhanced scans.

**Results and Discussion**

Table 1 shows the plain CT findings and their distribution amongst those patients in whom contrast medium was not administered, those in whom the infarcts enhanced, and those in which enhancement did not occur. A notable feature is the presence of only one enhancing lesion, which, on critical examination, could be termed isodense. However, contrast medium was only administered to one-third of patients with apparently normal scans because it was not considered to be indicated on the grounds that alternative diagnoses were most unlikely and management would not therefore have been altered by the result of an enhanced scan.

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