Clinics in Diagnostic Imaging (91)

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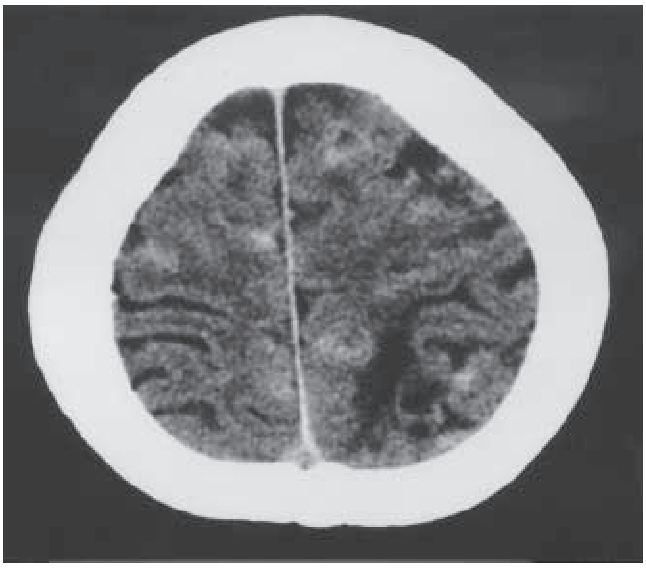

Fig. 1 Unenhanced axial CT scan of the brain.

CASE PRESENTATION

A 64-year-old Chinese woman complained of generalised weakness and headache for two days. This patient had medical history of hypertension on oral medication. On physical examination, she was conscious and alert, with Glasgow Coma Scale (GCS) of 15. She had generalised weakness in all four limbs, with power of four out of five, with no definite focal neurological deficit. All her vital signs were stable. Computed tomography (CT) of the brain (Fig. 1) was performed as an outpatient.

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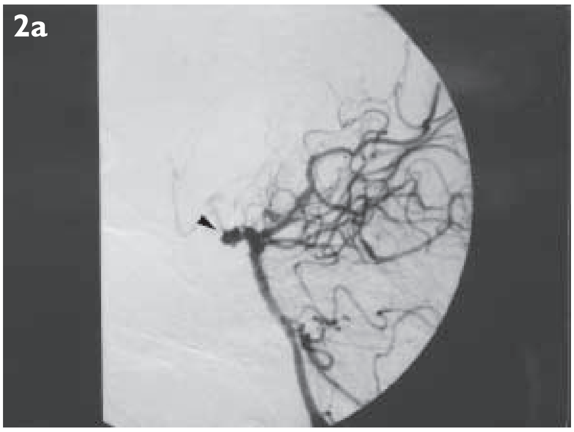

Fig. 2a Digital subtraction angiogram shows a left posterior communicating artery aneurysm (arrowhead). There were two other aneurysms in this patient; located in the left middle cerebral artery and in the right posterior communicating artery.

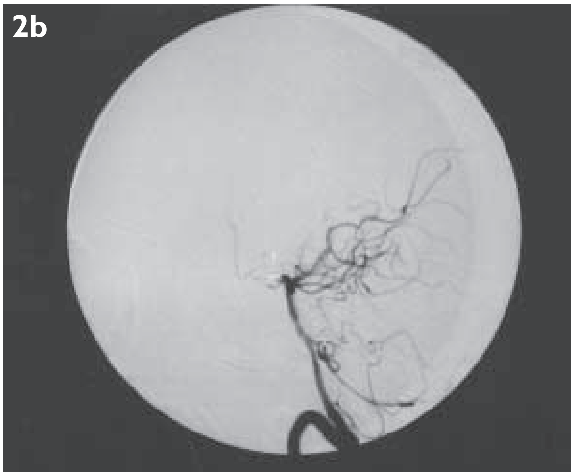

Fig. 2b Repeat digital subtraction angiogram shows the left posterior communicating artery after embolisation by GDC coils.

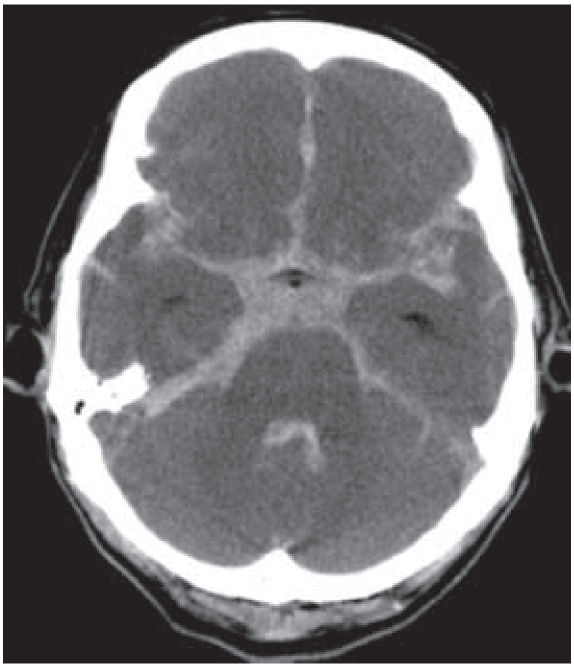

Fig. 3 A patient with typical subarachnoid haemorrhage. Unenhanced axial CT scan shows diffuse and bilateral high density areas in the subarachnoid space outlining the basal cisterns and Sylvian fissures.

IMAGE INTERPRETATION

The unenhanced CT scan (Fig. 1) shows patchy focal areas of increased density in the cerebral sulci bilaterally. There is also a focal area of low density in the left parietal lobe, consistent with previous cerebral infarction.

DIAGNOSIS

Subarachnoid haemorrhage.

CLINICAL COURSE

With the diagnosis of subarachnoid haemorrhage (SAH), probably from aneurysm rupture, the patient was immediately admitted. A cerebral angiogram was performed to find the source of aneurysmal bleeding, and a large left posterior communicating artery aneurysm was found (Fig. 2a), with two smaller aneurysms in the left middle cerebral artery and right posterior communicating artery. Therapeutic embolisation of the largest aneurysm in the left posterior communicating artery was performed (Fig. 2b). The patient subsequently underwent surgical clipping of the other two aneurysms, and recovered with only mild residual right hemiplegia and dysphagia.

DISCUSSION

A stroke is an injury to the central nervous system that is characteristically abrupt in clinical onset due to a vascular event, resulting in acute neurological deficit. Strokes are caused by cerebral infarction in approximately 80% of cases. Other non-ischaemic strokes may be caused by subarachnoid haemorrhage, intracranial haematoma, tumour, infection, arterial dissection and vascular malformation[1]. Computed tomography (CT) is the imaging modality of choice in the investigation of stroke[1] and is widely available in most hospitals. CT is sensitive in detecting haemorrhagic causes of stroke and often reveals the extent of cerebral infarction. The care path and management algorithm is different between haemorrhagic and non-haemorrhagic causes of stroke. Hence, correct interpretation of the initial CT scans greatly influences the appropriate selection of confirmatory diagnostic tests.

Unenhanced CT of the brain is extremely useful for detecting intracranial haemorrhage. It also has the advantages of widespread availability and is more practical for restless patients with altered consciousness. The attenuation of blood in CT is dependent on the haematocrit, the haemoglobin concentration and the protein content of the haemorrhage. An acute haematoma in an otherwise normal patient usually has high protein content and

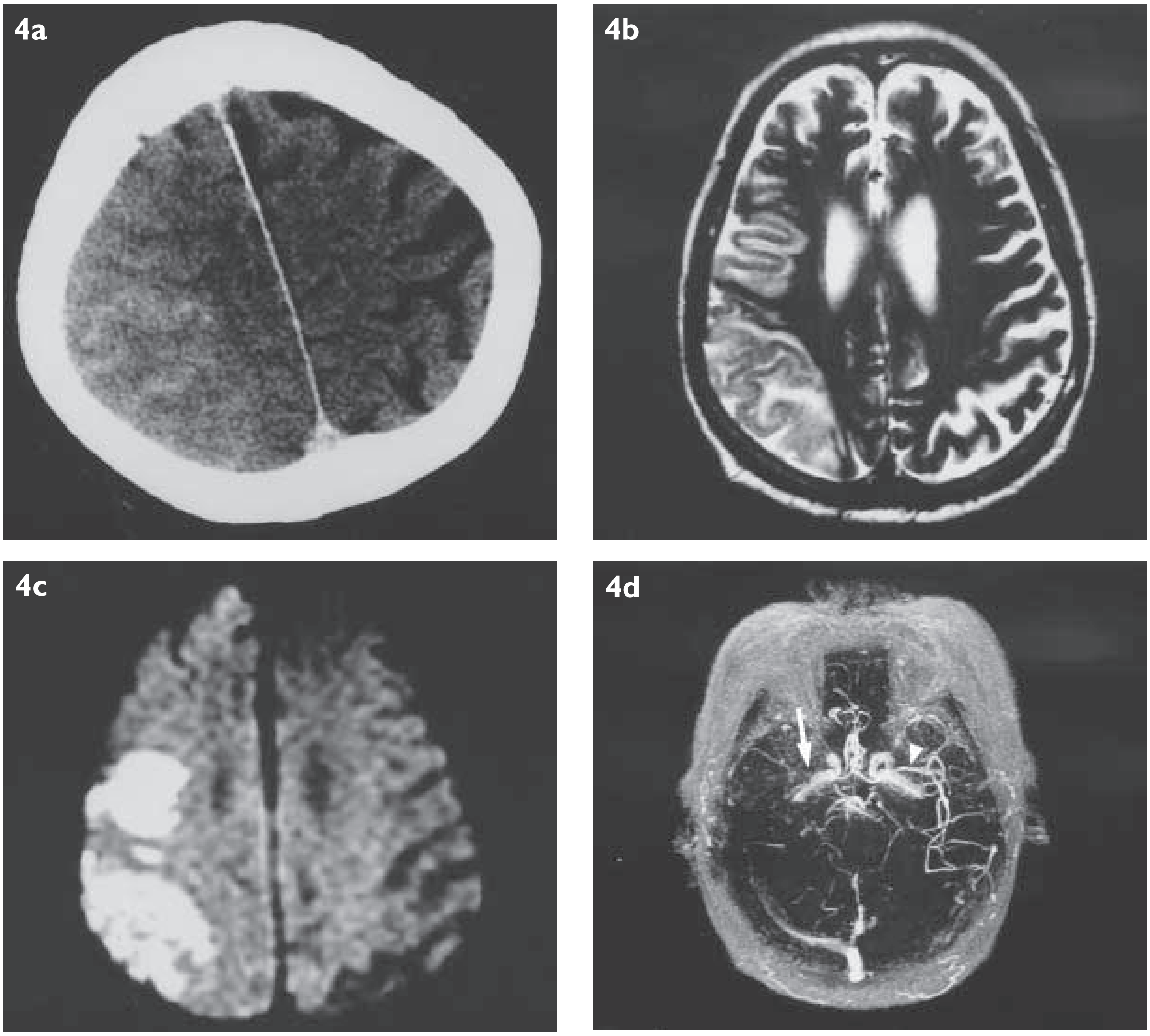

Fig. 4 A patient with acute cerebral infarction from right middle cerebral artery occlusion. (a) Unenhanced axial CT scan shows decreased density and loss of definition of the brain parenchyma in the right cerebral hemisphere, giving a spurious impression of increased sulcal density. (B) Axial T2-weighted MR image shows high signal in the middle cerebral artery (MCA) territory in the frontal and parietal cortex. (C) Corresponding diffusion-weighted (DW) MR image shows increased signal intensity, consistent with acute infarction. (D) MR angiogram shows loss of flow signal in the obstructed right middle cerebral artery (arrow), compared to normal flow signal on the left side (arrowhead).

a haemocrit of close to 90%, resulting in high CT density. Patients with coagulopathy or anaemia may not show the typical appearance of hyperdense haematoma. Acute bleeding may also not be hyperdense if the bleeding is very rapid or active re-bleeding is occurring during the time of the CT examination. Fresh blood that does not have enough time to retract is isodense to the brain parenchyma. In situations where fresh blood accumulates in a retracted clot, a hypodense area is seen within a hyperdense haematoma; this is called the “swirl” sign[2].

On CT, the detection of large amounts of subarachnoid blood is seldom difficult (Fig 3). SAH is typically seen as areas of high density located within in the subarachnoid spaces of the brain. The pattern of blood distribution often provides a clue to the location of the ruptured aneurysm. The prevalence of subarachnoid blood in the suprasellar cisterns and interhemispheric fissure is highly suggestive of an aneurysm of the anterior communicating artery or its branches. A “Sylvian haematoma” is almost pathognomonic of a middle cerebral artery aneurysm. Prevalence of blood in one crural cistern with third nerve palsy may be indicative of an ipsilateral posterior communicating artery aneurysm. Blood within the ventricles may rarely be due to direct rupture of an aneurysm within the ventricular system, and is in more commonly caused by reversed cerebrospinal fluid flow from the cisterns.

However, the diagnosis as SAH of small amounts of resolving subarachnoid blood, such as in this case, can be difficult (Fig. 1). Our patient probably presented with a small haemorrhage from a leaking aneurysm, before catastrophic aneurysmal rupture occurred. Such subtle clinical and radiological findings may be difficult to appreciate, especially in

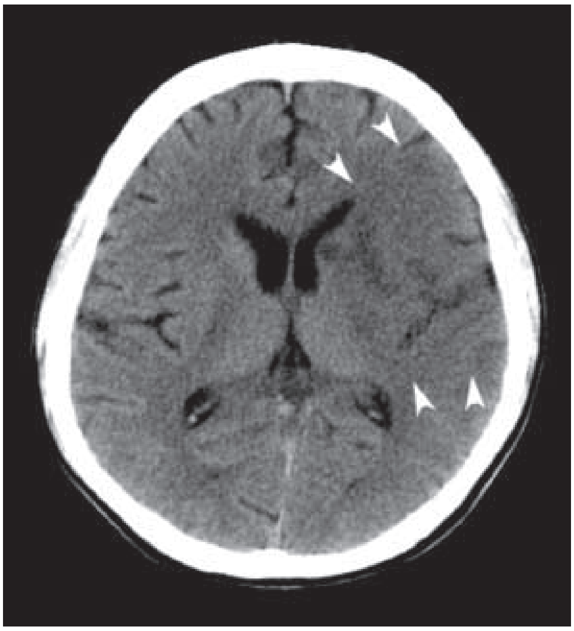
Fig. 5 A patient with typical MCA territory infarction. Unenhanced axial CT scan shows decreased density, loss of grey-white differentiation and sulcal effacement in the characteristic wedge-shaped territory of the left MCA (arrowheads).

the context of non-specific weakness and headache, rather than the more typical thunderclap headache of massive SAH.

In SAH, the patient should be admitted immediately if in an outpatient environment. Catheter angiography is the investigation of choice for assessment of SAH (Fig. 2). Digital subtraction angiography provides very high-resolution detection of the size and number of cerebral aneurysms. However, it is invasive and should be used judiciously in patients in whom it is indicated. Alternatively, magnetic resonance (MR) imaging or CT angiography may be non-invasive alternative methods to assess the intracranial vasculature[3]. One distinct advantage of catheter angiography is its ability to direct neuroradiological intervention. The treatment of intracranial aneurysms by occlusive coils (such as Gulielmi detachable coils) has emerged as a minimally-invasive alternative to traditional craniotomy and surgical clipping[4].

Sometimes, in cases of acute cerebral infarction, there is relative hyperdensity of the sulci among the hypodense infarcted gyri, simulating subarachnoid haemorrhage (Fig. 4). In such cases, close clinical consultation between neurosurgeons and neuroradiologists is critical. From these multidisciplinary discussions, the appropriate confirmatory test could be chosen, avoiding the need for unnecessary invasive angiogram, particularly in critically-ill or intubated patients. In acute ischaemia, the neurons in the gray matter become swollen and decrease in attenuation. This leads to loss of the differentiation between the cortical grey matter and the subjacent white matter. In addition, the accumulation of intracellular fluid causes neuronal swelling and cytotoxic edema, resulting in effacement of the normal sulci. These changes lead to the typical appearance of hypoattenuation in the region of infarcted brain tissue (Fig. 5).

In addition to imaging features of the effects of neuronal death, the cause of cerebral infarction may sometimes be seen on CT. The "hyperdense MCA sign" is a focus of visibly increased attenuation within the middle cerebral artery, and results from an embolic thrombus. This sign is associated with a poor outcome. A similar sign has also been described in the basilar artery[5]. However, not every patient will show such diagnostic features on CT, and MR imaging may be necessary for further evaluation. MR imaging is more sensitive and enables earlier detection of infarction than CT. Conventional spin-echo MR imaging has been shown to be positive in more than 80% of the cases of acute infarction on the first day, compared to 60% for CT[6], particularly for lacunar infarction and in the posterior fossa where CT suffers from beam-hardening artefacts.

Diffusion-weighted (DW) MR imaging is a novel functional MR pulse sequence that is sensitive to molecular diffusion of water. DW MR images are positive within a few minutes of the onset of cerebral infarction, and may be useful in differentiating acute from chronic infarction[7] (Fig. 4c), as well as assessing rare causes of ischaemia[8,9]. MR angiography, using time-of-flight, phase-contrast or contrast-enhanced methods, are viable alternatives to catheter angiography (Fig. 4d). Beyond visualising infarcted brain tissue, it would be desirable to image oligaemic tissue that has not yet begun the irreversible path to cell death. This poorly perfused but still viable tissue has been termed the ischaemic penumbra, and is the target of interventional therapy to limit the final volume of cerebral infarct[10]. MR-based techniques using spin-labelling or contrast-enhanced techniques are among the different methods to measure cerebral perfusion, and may be combined with MR angiography[11] and DW MR imaging during the same study.

There has been renewed interest in neuroimaging in acute cerebral ischaemia as a result of advances in therapeutic thrombolysis[12]. Both intravenous and intra-arterial methods may be used to deliver tissue plasminogen activator (tPA) to the obstructed intracerebral artery within hours of stroke onset[13]. In acute ischaemic stroke, digital subtraction angiography may be used to guide thrombolytic therapy especially as intra-arterial thrombolytic methods have been shown in some studies to have higher recanalisation rates and clinical outcomes than intravenous thrombolysis. It is hoped that with increased awareness of the expanded treatment options available, more patients may benefit from neuroimaging and radiology-guided intervention.

CONCLUSION

Computed tomography is the initial radiological study of choice for investigating acute neurological deficit. As is evident in the illustrated examples, haemorrhagic and ischaemic strokes require very different paths of management, and accurate interpretation of the initial CT study is therefore essential. Advanced neuroradiological techniques such as MR imaging and therapeutic neuroradiology using Gulielmi detachable coils are improving the options for further investigation and treatment of different types of stroke.

ABSTRACT

Computed tomography (CT) is the initial radiological investigation of patients with an acute neurological event. A 64-year-old woman presenting with generalised weakness and headache for two days was diagnosed on CT to have subarachnoid haemorrhage. Digital subtraction angiography confirmed the cause to be a ruptured posterior communicating artery aneurysm. The patient was treated by neuroradiological intervention using occlusive coils. The CT features of subarachnoid haemorrhage are discussed. Accurate CT interpretation is essential to direct appropriate investigations and management in patients with stroke, particularly as acute cerebral infarction may occasionally mimic subarachnoid haemorrhage. The role of magnetic resonance (MR) imaging in evaluation of cerebral infarct is also discussed.

Keywords: Subarachnoid haemorrhage, cerebral infarction, angiography, Computed tomography, Magnetic resonance imaging

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