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DOI: [10.1159/000120688](https://doi.org/10.1159/000120688)**Availability of CT and MR for Assessing Patients with Acute Stroke**I. Kane^a, W.N. Whiteley^b, P.A.G. Sandercock^b, J.M. Wardlaw^b^aDepartment of General Medicine, St. Richard's Hospital, Chichester, ^bDivision of Clinical Neurosciences, University of Edinburgh, Edinburgh, UK*Background*

Brain imaging is essential for the selection of stroke patients for thrombolysis. The imaging method must be available rapidly at all times, quick to perform, and able to exclude intracerebral haemorrhage and mimics of stroke [1]. Computerised tomography (CT) scanning is already widely available [2–4] and cost-effective [5]. However, signs on CT indicating ischaemic stroke are subtle within the first few hours of symptom onset and can be hard to see in people with leukoaraiosis or previous stroke [6].

Magnetic resonance imaging (MRI) may provide more information than CT in patients with acute stroke. For example, diffusion-weighted imaging (DWI) MR may be more sensitive than CT at detecting ischaemic stroke in patients with mild symptoms [7], and gradient echo more sensitive for showing old haemorrhages in patients who present several days after their stroke [8]. There is increasing pressure that MR should be the method of choice to select patients with acute stroke for thrombolysis [9] and the first-line imaging method for all stroke [10] (though there are practical difficulties in performing MR in about 20% of stroke patients) [11, 12].

At least 2 acute stroke trials in progress are assessing the use of MRI DWI to select patients [13, 14]. If it is established that MR improves selection for thrombolysis, we sought to identify whether the UK would be in a position to provide this imaging modality for patients with acute stroke. We therefore surveyed all acute hospitals in the UK admitting patients with acute stroke to assess their access to MRI.

Methods

We assembled a database of the 268 hospitals in the UK that admitted acute stroke patients, from the National Sentinel Stroke Audit [2] and the Scottish Stroke Audit [4]. We sent a short questionnaire to the lead stroke clinicians at each hospital, with a covering letter and stamped addressed envelope in February 2005. For centres with access to MRI, we sought further details on the capacity of their MRI machines both in and out of normal working hours. The questionnaire included visual analogue scales to assess the ease of access to MRI, which were measured with a scale from 0 for 'impossible' to 12 for 'very easy'. We arbitrarily defined 'difficult' as a score between 0 and 5. We sent a reminder to those who failed to respond on the first occasion.

Results

The total number of replies was 248/268 (93% of the total number of admitting hospitals). The survey was complete by the end of 2005.

Access to CT

Of the hospitals admitting acute stroke patients, 240 (97%) had a CT scanner on site. Only 8 had neither CT nor MRI, of which 3 were in rural areas (174–402 km to their nearest scanner). The remaining 5 hospitals with no CT or MRI were very small units about 32 km from their nearest scanner.

Access to MRI

Most hospitals that admitted patients with acute stroke had MRI facilities on site (192/245; 78%). Of the 192 hospitals with MR, 3 used mobile units which were not available 24 h a day. All the hospitals that had MR also had CT (fig. 1).

Forty-eight hospitals had on-site CT but no MRI. Of the 46 respondents, the average distance to an MRI machine was 37 km (range 0.8–129).

Although more than three quarters of hospitals had MRI in their hospital, access for stroke patients was difficult. Seventy-three percent of hospitals found MRI access difficult during working hours and 95% out of hours.

Fig. 1. UK availability of scanning facilities for acute stroke.

Table 1. Number of hospitals carrying out MRI scans on acute stroke patients within the previous 6 months

Estimated number of patients scanned	<6 h after stroke (number of hospitals)	<12 h after stroke (number of hospitals)	At any time after stroke onset (number of hospitals)
None	137	117	8
1–5	17	29	34
6–10	3	3	40
>10	1	5	59
Totals	158	154	141

Few patients had MRI within 6 h of stroke (table 1). Within the 6 months preceding the survey, only 21/192 (11%) hospitals with MR on site had performed MR on any patients within 6 h of stroke onset and 58/192 (30%) had scanned any patients within 12 h of stroke.

Discussion

CT scanning was available in almost all UK hospitals admitting patients with acute stroke. Although 78% of such hospitals had access to MRI, it was rarely available sufficiently quickly to be of value in the management of patients with acute stroke. Making a number of assumptions about patterns of acute stroke care, we estimated that for the year 2005 in the whole of the UK about 300 patients with acute stroke had MRI within 6 h of stroke; about 0.2% of all new strokes in the UK. This may be an underestimate, but even if we have erred by a factor of 10 (which would not accord with our experience), the total would still only be 2%. We believe this estimate of MRI service provision to be realistic in view of the excellent response rate (93%). The Royal College of Physicians Sentinel Stroke Audit [2] tends to confirm this and found that although 88% of stroke units had access to MRI scanning, it was only available urgently in 53%. This contrasts with 91% of units having access to emergency CT scanning.

Does this survey indicate that stroke patients in the UK are disadvantaged? For routine use of thrombolysis, perhaps not. Immediate CT scanning for acute stroke is a highly cost-effective CT strategy [15]. In patients who are candidates for thrombolysis, CT within the first few hours of stroke with a structured interpretation is as good as MR with DWI in identifying early ischaemic change [12], though in milder stroke, MRI may be more sensitive [16]. Both CT and MR can assess cerebral perfusion in the acute phase, and it remains unclear which will be the best test for selecting patients for thrombolytic therapy.

Although this survey demonstrates that there is wide provision of MRI equipment in the UK, the proportion of scanners per head of population is still less than in the best resourced areas of Europe or North America [17]. Many UK centres now have access to MRI and at least 1 UK centre has audited the use of MR as first-line imaging for suspected stroke [18]. We have not found any comparable nationwide surveys of access to MR for patients with acute stroke in other countries, although MR is reported to be difficult to access in some countries [19]. However, access to imaging for stroke patients depends on more than the mere presence of an MR scanner. Stroke competes with many other diseases, which often affect a younger population who are perceived to be needier.

Demands on CT and MR are substantial, with radiology departments dealing with many competing priorities. Better access to MRI (and CT) for stroke patients requires not only more machines but also extended operating hours and increased funding for support by clinical radiologists (currently a shortage specialty). If the UK, one of the most prosperous countries in Europe (ranked fourth in the world by GDP), has yet to provide rapid access to MR for all patients with acute stroke, how can less wealthy countries be expected to provide MR for all?

Therefore, in many countries, CT may well continue to be the 'workhorse' imaging modality in acute stroke, since it is universally available – without delay – to patients with acute stroke; for a trained reader, it is as sensitive as DWI MR; and perfusion CT imaging may prove to be as effective as MR perfusion for selecting patients for thrombolysis. On the other hand, for milder strokes, strokes presenting late and other areas of cerebrovascular disease, MR still has advantages over CT and does not involve ionizing radiation, so the drive to increase the availability of MR around the world for patients with stroke should continue.

Competing Interests and Funding

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Reversible Posterior Encephalopathy Syndrome Followed by MR Angiography-Documented Cerebral Vasospasm in Preeclampsia-Eclampsia: Report of 2 Cases

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Introduction

Posterior reversible encephalopathy syndrome (PRES) is a rare complication of preeclampsia-eclampsia [1]. The characteristic neuroradiological findings are multifocal and often symmetric, increased T2 or diffusion-weighted signal intensity lesions in the posterior dominant white and gray matter [2]. Diffusion tensor imaging (DWI) changes support the hypothesis that vasogenic edema is the pathophysiological mechanism underlying this syndrome [2]. Several reports, however, associate PRES with cyto-

toxic edema, ischemic stroke, and angiographic vasospasm [3–6]. These findings suggest an interrelationship between PRES and cerebral vasospasm. We report two preeclamptic-eclamptic patients with clinical and neuroradiological features of PRES. In these patients, MR angiography (MRA) showed reversible vasospasm of large- and medium-sized cerebral arteries. The vasospasm was not present initially, and was preceded by the development of vasogenic edema.

Case Reports

Patient 1

A 28-year-old Japanese woman, gravida 2, para 0, with a twin pregnancy, suddenly developed a severe headache and vomiting at 35 weeks and 5 days of gestation. She had no evidence of cardiac, pulmonary, renal or cerebrovascular disease. Her blood pressure was 178/80 mm Hg, with proteinuria of 7.8 g/24 h. Neurological examination was normal. Hematological, renal and liver function tests were also normal. A diagnosis of preeclampsia was made. She was started on intravenous magnesium sulfate for seizure prophylaxis, and an emergent cesarean delivery was performed for breech presentation. Two male infants weighting 2,302 and 1,948 g were delivered, and both did well.

Four hours postoperatively, the patient grew disoriented and became obtunded. Her blood pressure was 170/110 mm Hg. A complete blood count showed no major abnormalities with a platelet count of 160,000/ μ l. Her electrolytes and renal function tests were normal. Brain magnetic resonance imaging (MRI) showed multifocal areas of edema with hyperintense signals on T2-weighted and fluid-attenuated inversion recovery (FLAIR) images in the bilateral frontal, parietal, and occipital gray and white matters, basal ganglia, brainstem and bilateral cerebellum (fig. 1a). These areas showed predominantly high signals on DWI that corresponded to high signal intensities on an ADC map. These findings represented vasogenic edema. However, some of the diffusion-hyperintense lesions in the bilateral basal ganglia and left cerebellum showed low-signal intensities on the ADC map. This was consistent with cytotoxic edema. An MRA at this time did not show any significant abnormalities except for an aneurysm at the right internal carotid-ophthalmic artery (fig. 1b). The patient was treated with sodium nitroprusside, nicardipine, magnesium sulfate, glycerol, and the free radical scavenger edarabone. The next day, she recovered consciousness without neurological sequelae. On postpartum day 4, her headache had resolved and her blood pressure stabilized at 120/70 mm Hg.

A follow-up MRI on postpartum day 4 showed resolution of the high signal areas on FLAIR and T2-weighted images (fig. 1c); however, MRA revealed multifocal irregular narrowing of the bilateral anterior cerebral arteries (ACAs), middle cerebral arteries (MCAs), and posterior cerebral arteries (PCAs). This was consistent with vasoconstriction (fig. 1d). An extensive workup for cerebral vasculitis was negative. Additionally, microbiological, autoimmune and thrombophilia studies showed no abnormalities. On postpartum day 13, the patient's blood pressure had returned to normal without any medications, and she had no proteinuria. All neuroradiological abnormalities had resolved on a repeat brain MRI and MRA performed on postpartum day 13. The patient had recovered completely with no neurological deficits on postpartum day 22, and was discharged.