

Acute ‘limited’ magnetic resonance imaging in childhood stroke—an illustrative case

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Abstract Paediatric stroke is a major cause of morbidity and death in children. There is often a delay in making the diagnosis because common differential diagnoses such as migraine and seizures need to be considered and quick access to imaging is difficult. Early recognition is increasingly important for early treatment and to improve outcomes. We present the case of a 4-year-old boy who presented to the Emergency Department with acute hemiparesis. To target the provisional diagnosis of an acute ischaemic stroke, we requested magnetic resonance imaging (MRI) limited to two sequences only: diffusion weighted imaging (DWI) and susceptibility weighted imaging (SWI). We were able to confirm the diagnosis of acute ischaemic stroke within 90 min of presentation to hospital.

Keywords Childhood stroke · Magnetic resonance imaging

Introduction

Paediatric stroke is a major cause of morbidity and death in children. There is often a delay in making the diagnosis

because common differential diagnoses such as migraine and seizures need to be considered and quick access to imaging is difficult. Early recognition is increasingly important for early treatment and to improve outcomes. We present the case of a 4-year-old boy who presented to the Emergency Department with acute hemiparesis. To target the provisional diagnosis of an acute ischaemic stroke, we requested magnetic resonance imaging (MRI) limited to two sequences only: diffusion weighted imaging (DWI) and susceptibility weighted imaging (SWI). We were able to confirm the diagnosis of acute ischaemic stroke within 90 min of presentation to hospital.

Case

The child was a previously healthy 4-year-old boy. In the 2 weeks prior to presentation, he complained of intermittent headaches and vomited several times. On the morning of presentation, he had woken from his night sleep as usual and was watching TV, when he developed a sudden-onset right-sided hemiparesis around 0830. His mother observed him at home for 3 h and then drove him to hospital where he was triaged at 1215.

On arrival, he had a flaccid right-sided hemiparesis, right facial droop and slurred speech. He was briefly reviewed by the ED physician and promptly referred to the paediatric neurology team by 1245. We arranged an urgent MRI. The boy was taken to the scanner (Siemens Aera 1.5T) at 1335 and was cooperative enough to tolerate two sequences without sedation—a diffusion weighted sequence (B0, B1000, ADC map) and a SWI sequence (with maximum intensity projections). These took 5 min to run.

We confirmed a large posterior circulation acute ischaemic stroke (AIS) without evidence of haemorrhagic transformation

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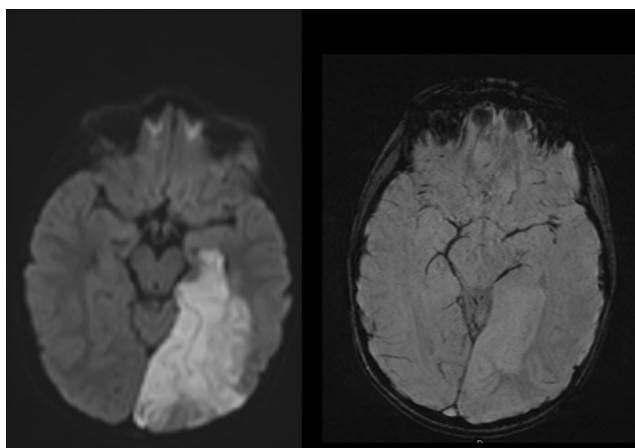


Fig. 1 DWI show an acute ischaemic stroke in the posterior circulation territory; SWI images do not show any evidence of haemorrhage. This result was available after 5 min in the MRI scanner

(Fig. 1). Because of the size of his infarct and the risk of haemorrhage, we opted against anticoagulation therapy and started him on aspirin. Later MR imaging subsequently revealed a dissection of his left vertebral artery.

Discussion

Acute ischaemic stroke in children is thought to be slightly more common than brain tumours, with a yearly incidence of 2–13 per 100,000 children [1]. Children who have sustained a stroke demonstrate a lower level of ability than would be expected for their age across self-care, mobility and social domains [2]. About 50 % of childhood stroke survivors will have ongoing neurological disability [3]. Early diagnosis is likely to become increasingly important to improve outcomes particularly if revascularisation therapies are considered. So far, successful i.v. thrombolysis in children has mainly been described in single case reports. It should be considered as an acute intervention especially in older children and adolescents.

Establishing a stroke diagnosis requires brain imaging. MRI including diffusion weighted images is the imaging modality of choice to confirm an acute ischaemic infarct especially in the first 12 h after presentation [4]. SWI images are especially useful in identifying cerebral haemorrhage and cerebral microbleeds (CMB) which may be early predictors of haemorrhagic transformation [5]. SWI may also identify small volumes of subarachnoid or subdural haemorrhage. Cerebral calcifications can cause artefact on computed tomography (CT) and may be confused with cerebral haemorrhage; however, SWI phase sequence allows differentiation of calcification from blood. Should SWI sequences not be available or interpretation limited by motion, the B0 sequence can be

obtained as part of the DWI to evaluate for intracranial haemorrhage.

Another sequence that can be helpful in limited stroke evaluation is fluid-attenuated inversion recovery (FLAIR), which can detect oedema and evaluate intracranial vessels. Vessels with an acute thrombus or slow flow may appear bright on FLAIR, providing the necessary information without the need to perform an additional MRA sequence.

Fast access to a scan in order to establish the definite diagnosis is frequently difficult to organise. Srinivasan et al. reviewed a cohort of 88 children and found median time from onset to diagnosis of AIS was 24.8 h [6]. Rafay et al. found that time from initial assessment to neuroimaging in their tertiary referral centre was on average 8.8 h (range 4.5 to 33.5 h) [7].

Late presentation to hospital and under-recognition by medical staff play an additional role in delaying the diagnosis [2].

CT as alternative imaging modality involves radiation and is associated with an increased cancer risk, especially in early childhood. More importantly, AIS may be missed on CT especially in the first hours after symptom onset [4, 8, 9]. CT scans remain invaluable, however, in critical situations where the benefits of a quick scan outweigh the risks of radiation even in children.

In our experience, a delay in imaging is more likely in younger children who require sedation or a general anaesthetic. Our local stroke protocol for adults includes axial T2, sagittal T1, time-of-flight MRA (intracranial), axial FLAIR and axial DWI. Time-of-flight MRA (extracranial), SWI sequences and axial fat-saturation sequences for evaluation of cervical vascular dissection may be added. Other stroke protocols specifically for paediatric patients have been published [10]. The average time required to run the above protocol is 15–30 min. A young child will usually not tolerate this without a general anaesthetic. Anaesthetists in this setting are reluctant to consider an emergency general anaesthetic because children are less likely to be fasted. Sedated studies are also very disruptive for the radiology department.

By requesting only two MRI sequences which took only 5 min, we were able to obtain a timely MRI scan without sedating the child. Sharma [11] postulates that there are many clinical scenarios in which a specific clinical question can be answered by a single MR sequence. We had no problem negotiating emergency imaging with the radiology department for a scan of 5 min duration. With the MRI result, we were able to choose and commence appropriate therapy promptly.

Conclusion

Limiting MRI to two sequences (DWI and SWI) was tolerated well in a young child without sedation, allowing for a fast and

accurate diagnosis of AIS as well as directing choice of treatment. Rapid diagnosis becomes crucial if revascularisation treatment is to be considered. We postulate that limited MRI sequences should be considered in all young children who present to hospital with a history suggesting stroke. This reduces the time from onset of symptoms to diagnosis. MRI with additional sequences can be arranged subsequently.

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Conflict of interest The authors declare that they have no conflict of interest.

References

- deVeber G, The Canadian Pediatric Ischemic Stroke Study Group (2000) Canadian pediatric ischemic stroke registry: analysis of children with arterial ischemic stroke. *Ann Neurol* 48:526
- Galvin J, Hewish S, Rice J, Mackay MT (2011) Functional outcome following paediatric stroke. *Dev Neurorehabil* 14(2):67–71
- Ganesan V, Hogan A, Shack N, Gordon A, Isaacs E, Kirkham FJ (2000) Outcome after ischaemic stroke in childhood. *Dev Med Child Neurol* 42:455–461
- Mullins ME, Schaefer PW, Sorensen AG, Halpern EF, Ay H, He J, Koroshetz WJ, Gonzalez RG (2002) CT and conventional and diffusion-weighted MR imaging in acute stroke: study in 691 patients at presentation to the emergency department. *Radiology* 224:353–369
- Gasparotti R, Pinelli L, Liserre R (2001) New MR sequences in daily practice; susceptibility weighted imaging. A pictorial essay. *Insights Imaging* 2:335–347
- Srinivasan J, Miller SP, Phan TG, Mackay MT (2009) Delayed recognition of initial stroke in children: need for increased awareness. *Paediatrics* 124:e227
- Rafay M, Pontigon A, Chiang J, Adams M, Jarvis DA, Silver F, MacGregor D, deVeber G (2009) Delay to diagnosis in acute pediatric arterial ischaemic stroke. *Stroke* 40:58–64
- Mathews JD, Forsythe AV, Brady Z, Butler MW, Goergen SK, Byrnes GB, Giles GG, Wallace AB, Anderson PR, Guiver TA, McGlae P, Cain TM, Dowty JG, Bickerstaffe AC, Darby SC (2013) Cancer risk in 680 000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. *BMJ* 346:f2360
- Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Kim KP, Howe NL, Ronckers CM, Rajaraman P, Sir Craft AW, Parker L, Berrington de Gonzalez A (2012) Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. *Lancet* 380(9840):499–505
- Saunders D, Thompson C, Gunny R, Jones R, Cox T, Chong WK (2007) Magnetic resonance imaging protocols for paediatric neuro-radiology. *Pediatr Radiol* 37:789–797
- Sharma A (2014) A case for changing the way we utilize MR imaging: a societal perspective. *J Am Coll Radiol* 11(10):931–932