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Right middle cerebral artery infarct after minor head trauma in an infant: Case report and literature review

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ABSTRACT

Ishaemic stroke (IS) in the paediatric population is extremely rare. In this age group, the occurrence of IS often concurs with underlying congenital heart disease, haematological, metabolic or immunological conditions. In contrast, the association between IS and minor head injury in children has been sparse in current literature. The authors report a case of a healthy 9-month-old male who was found to have a right middle cerebral artery territory infarct after a minor head injury. An extensive medical workup was performed, and it was negative for any previously undiagnosed co-morbidities. Given the paucity of such cases, the condition and its management are discussed in corroboration with current literature.

1. Introduction

The incidence of ischaemic stroke (IS) in pediatrics is rare. Conversely, in the aging population, strokes are common with well-established risk factors associated with IS include nutrition, hypertension, coagulopathy disorders, carotid stenosis, and patent foramen ovale [1]. However, in young adults, the list of potential stroke causes is extensive. According to the TOAST (Trial of Org 10172 in Acute Stroke Treatment) criteria, both strokes of undetermined and of other determined etiology are the most common types among them [2]. Broadly speaking, causative factors in children can be similar to young adults whereby the diagnosis is often linked to a background of congenital heart disease, haematological and, or immunological conditions. Interestingly, there have been reports of IS associated with head injury in patients less than 12 months of age [3]. The authors describe the case of a 9-month-old child who developed progressive unilateral hemiparesis secondary to a right middle cerebral artery (MCA) territory infarct after a minor head injury. Given the infrequency of such cases, the condition is discussed in corroboration with current literature.

2. Case report

A previously well 9-month-old male of non-consaginous parents presented to the Children's Emergency Department after a fall. According to the history, the child crawled to the end of an adult bed, fell off and landed on the left side of his head and body. No loss of consciousness, seizure, nausea or vomiting was observed. However, he was noted to be subsequently irritable and showed reluctance moving his shoulder and left arm. The latter was presumed to be secondary to discomfort from the fall.

Physical examination demonstrated that he had a full Glasgow Coma Scale with bilaterally equal and reactive pupils. There was normal extraocular movement and no facial asymmetry. No scalp haematoma, significant skin swelling or bruise was noted. His anterior fontanelle was normotensive. However, his left upper limb demonstrated motor power 3 out of 5. Muscle tone in all 4 limbs

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was normal. X-rays of his left shoulder, clavicle and forearm did not show any fracture or dislocation. He was admitted for close neuro-monitoring based on the working diagnosis of a minor head injury.

On the following day, he was found to have new onset of left upper motor neurone facial asymmetry, and left lower limb weakness (power 3 out of 5) associated with hypertonia and hyperreflexia. In addition, there was no clinical improvement of his previously documented left upper limb weakness. No neurological deficit observed on his right side. The remainder of his cranial nerves was intact. An urgent magnetic resonance imaging (MRI) brain reported restricted diffusion in the right corona radiata and right lentiform nucleus, in keeping with a right MCA territory infarct. No midline shift, hydrocephalus or effacement of the basal cisterns was seen. MR angiography demonstrated no flow-limiting stenosis of the anterior or posterior cerebral circulation. No arteriovenous malformation was seen. (Fig. 1). The patient also developed a cluster of focal seizures after his MRI, whereby he was noted to episodes of left eye deviation associated with stiffening and flexion of his left upper and lower limbs. The seizure was managed with benzodiazepines and phenobarbitone under the guidance of the neurologist. No further seizures was noted after and he returned to his baseline Glasgow Coma Scale of 15.

As part of the stroke workup, a comprehensive list of relevant cardiac, haematological, immunological and metabolic investigations was performed to exclude the possibility of underlying medical conditions for the cause of his IS. Overall, the workup was largely unremarkable, except for his plasma Protein C and S results which were borderline low. (Tables 1 and 2). His collective results were also reviewed by a haematologist who was of the opinion that the latter values were likely reactive to the intracranial event and hence, deemed equivocal at this stage. The recommendation was for an interval serum Protein C and S in approximately 6 months from the initial test. A detailed family history was also taken to exclude any hereditary causes for stroke, and this was negative. The patient was started on aspirin for his IS and there were no further neurological events after. In addition, he was commenced on an intensive neuro-rehabiliation programme to optimize his recovery. At 4 months post-IS, the patient still maintained a left hemiparesis. However, there were no more documented seizures. At the time of this writing, the patient was still attending regular neuro-rehabilitation and his neurologist was tailing down his anti-epileptic medication(see: Fig. 2).

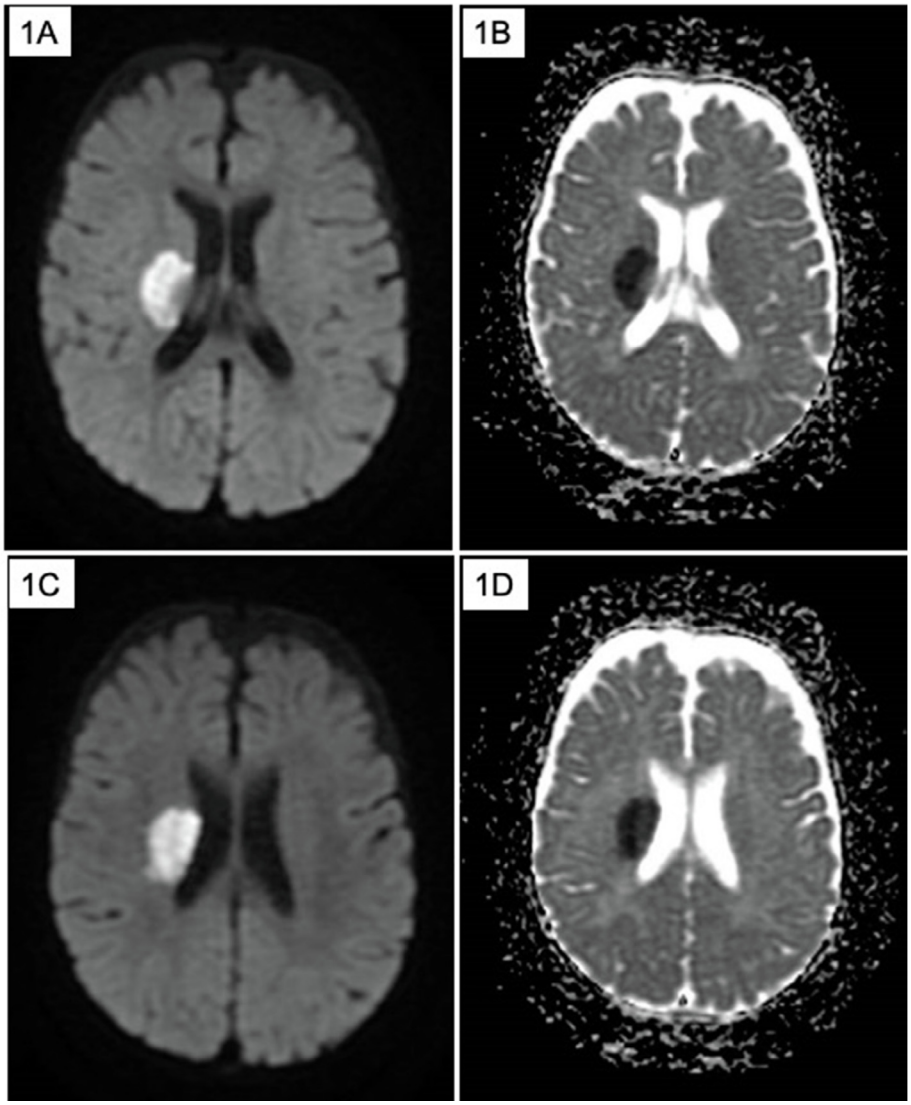

Fig. 1. Representative axial DWI (diffusion-weighted imaging) and corresponding ADC (apparent diffusion coefficient) MRI images showing an acute infarct involving the right lentiform nucleus (**1A and 1B**) and corona radiation (**1C and 1D**).

Table 1
List of investigations performed for patient as part of his stroke workup.

INVESTIGATION	RESULT	REFERENCE RANGE
Haemoglobin	11.9	11.5–15.5 g/DL
Haematocrit	34.6 ↓	35.0–45.0%
White blood cell count	14.45	6.00 to 17.50 10(9)/L
Platelet count	322	140 to 440 10(9)/L
C-reactive Protein	0.3	0.0–5.0 mg/L
Erythrocyte sedimentation rate	7	1–10 mm/hour
Prothrombin Time	12.7	11.5–15.3 seconds
Activated Partial Thromboplastin Time	38.9	35.1–46.3 seconds
Fibrinogen	1.98	0.82–3.83 g/L
Anti Thrombin III	108	80–120%
Protein C	68 ↓	70–140%
Protein S (Total)	63 ↓	75–140%
C3 Complement, serum	1.07	0.51–1.60 g/L
C4 Complement, serum	0.18	0.07–0.30 g/L
Homocysteine, blood	3.8 UMOL/L	Not applicable
Lactate, plasma	2.9 ↑	0.5–2.2 mmol/L
Ammonia, plasma	35	14–50 μmol/L
Free T4	12.7	10.3–25.7 pmol/L
Thyroid Stimulating Hormone	2.76	0.50–4.50 mIU/L
Thyroid Peroxidase Antibodies, serum	16.4	0.0–60 U/ML
Sodium, serum	137 ↓	139–146 mmol/L
Potassum, serum	5	4.1–5.3 mmol/L
Bicarbonate, serum	19	14–22 mmol/L
Chloride, serum	107	98–107 mmol/L
Urea, serum	2.7	1.2–6.0 mmol/L
Creatinine, serum	36	28–47 μmol/L
Organic Acids, urine (Creatinine)	4.88 mmol/L	Not applicable
Alanine transaminase, serum	29	5–33 U/L
Protein Total, serum	62	44–71 g/L
Bilirubin Direct, serum	2	1–5 μmol/L
Aspartate Transaminase, serum	39	20–67 U/L
Alkaline Phosphatase, serum	226	143–552 U/L
Albumin, serum	41	25–46 g/L
Gamma-Glutamyl Transferase, serum	9	8–127 U/L
Bilirubin Total, serum	5	3–20 μmol/L

Of interest, the haematocrit, serum sodium, Proteins C and S are slightly below their reference ranges; while the lactate is slightly elevated. Putting all the results and the clinical picture into context, these findings were evaluated to be non-actionable at the time of review.

3. Discussion

Ischaemic stroke (IS) is an important cause of long-term morbidity in the paediatric population. Neurological sequaelae may include sensorimotor deficit, language impairment, intellectual disability, behavioral problems, and seizures [4]. Given the onset of illness is during childhood, this may lead to devastating effects on the quality of life and cumulative economic expenses for the affected patient, family and society [5]. In current times, preventative measures by addressing risk factors associated with IS have significantly contributed to its prognosis. However, for IS as a consequence of head injury is harder to treat, particularly in the setting of minor head injuries whereby the probability is low. This is in contrast to severe head injury, where there is already an established relationship between the former and risk of stroke [6].

Owing to the paucity of cases, guidelines for the management of this particular group of patients are not well established. In comparision to adults, children with strokes present differently often have unique risk factors that are less common. In addition, presumptive risk factors for paediatric stroke often differ in children compared with adults [7,8]. Despite an increased incidence of paediatric stroke, there is often a delay in diagnosis, and patients may remain under and, or misdiagnosed [5,7]. A key contributing factor is the limited expressive and interpretive skills of symptoms presented by young children [9]. Furthermore, patients may present with subtle symptoms that mimic other diseases, leading to a low level of suspicion by the attending clinician [5]. With the benefit of recent insights, we are now aware that studies show that the risk of stroke is higher for 2 weeks after trauma. Onset is frequently delayed, providing an opportunity for stroke prevention during this period [10]. However, various studies report that the majority of children admitted for minor head injury generally have a good outcome [11–16]. Presumably, this may cause potential patients to have their diagnosis of IS to be delayed. Therefore, the current challenge is to identify specific children who are at higher risk of developing IS in the cohort of children diagnosed with minor head injury.

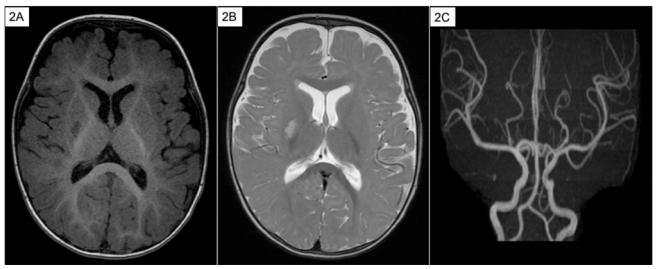

Fig. 2. Representative axial T1-weighted (**2A**) image showing hypointense signal in the right globus pallidus and putamen region. The corresponding T2-weighted (**2B**) MRI image shows hyperintense signal in the same region as **2A**. Magnetic resonance angiography (**2C**) demonstrates no evidence of flow-limiting stenosis. Of interest, these MRI images are incongruent with the previously described MRI findings of mineralizing microangiopathy [24]. However, these findings are also consistent with the negative MRI results seen in lenticulostriate mineralization—the subtype of mineralizing microangiopathy associated with acute basal ganglia stroke in infants presenting after minor head injury [17].

Broadly speaking, the main target of treatment of IS is the protection of the developing brain by minimizing acute brain injury, preventing neurodevelopmental impairment and disability [7]. Nonetheless, due to the lack of data from paediatric studies, there are no established guidelines specifically for paediatric IS [7]. Current treatment options for paediatric IS are often extrapolated from adult studies [7]. Hence, given the circumstances of this case, the use of anti-platelet treatment will be considered therapeutic.

Recently, we are now aware of an interesting entity, mineralizing microangiopathy, in particular, a subtype known as lenticulostriate mineralization, that has been reported to be associated with acute basal ganglia strokes after minor trauma in children [17,18]. Mineralizing microangiopathy has been described as a form dystrophic calcification within the brain substance, predominantly involving the basal ganglia and subcortical white matter [19].

Table 2
Remaining specialized investigations completed as part of stroke workup.

Investigation	Result
Acrylcarnitine, plasma	No significant abnormality in amino acids profile.
Prothrombin G20210A Assay	Normal (wild-type). Prothrombin (c*97G > A) allele not detected.
Factor V Leiden	Normal (wild-type). No evidence of Factor V Leiden.
Ultrasound Doppler Carotid Vessels	Bilateral carotid arteries patient with dissection or thrombus noted.
Transthoracic Echocardiogram	Structurally normal heart. Normal doppler and colour flow study.
Transthoracic Echocardiogram, Contrast Study	No left to right shunt

Previously, it was reported to develop after combined chemotherapy and radiation treatment of paediatric CNS neoplasms [20–22], and in some cases, earlier exposure to viral infection [23]. Nonetheless, causative reasons for the idiopathic mineralization of the involved vessels, usually the lenticulostriate arteries, remain unknown [17]. The latter is postulated to represent a more severe and persistent form of lenticulostriate mineralization [17]. Radiological abnormalities for this condition have been demonstrated to be best visualized on computed tomography (CT) whereby punctate areas of calcification may be identified within the basal ganglia, dentate nuclei and subcortical white matter [17,19]. Furthermore, specifically for lenticulostriate mineralization, thin-section, high-resolution spiral CT with multiplanar reconstructions is recommended to be the imaging modality of choice. This is because the standard CT for head injury with 5 mm axial sections may not pick up the true nature of the vascular mineralization [17]. In contrast, MRI features of MM may neither be straightforward nor visible [17,24]. Our patient's MRI findings concur with the literature that the relevant images were unable to appreciate the presence of calcium. However, this can be due either there was no mineralization to begin with, or our MRI was not sensitive enough to pick up this particular particulate. With reference to our case, the preference for an initial MRI brain was based on physical assessment of the patient which correlated with that of a stroke. Furthermore, the clinical management of IS, even in the context of mineralizing microangiopathy, is similar; that is, anti-platelet therapy and neuro-rehabilitation.

Following that, the propensity for mechanical vascular injury during head injury may be related to the relatively unmyelinated brain in infancy. In contrast to the more firm tissue turgor of myelinated brain, the unmyelinated brain tends to be susceptible to mechanical distortion even with minor head injury [23]. With regards to high-resolution CT scans, there are also genuine concerns about ionizing radiation and the theoretical risks of low-level radiation carrying a small risk of causing cancer [25,26]. Given that firstly, the MRI was sufficient to diagnose the IS; next, regardless of its underlying cause, the treatment for IS is similar; and finally, the possible sequealae of excess radiation; we were therefore, hesitant in the use of a high-resolution CT scan for an otherwise healthy 9-month-old patient. Nonetheless, we are in agreement that mineralizing microangiopathy is an extremely important entity in this infrequent cohort of vulnerable patients, and thus, should be further characterized.

4. Conclusion

In summary, the authors present a case of a healthy 9-month-old male who was found to have a right MCA territory infarct after a relatively minor head injury. Based on the circumstances of his admission, radiological findings and multiple investigations for existing co-morbidities, the working diagnosis was likely IS secondary to a minor head injury event. From the clinical perspective, the working diagnosis of mineralizing microangiopathy in the patient is possible, but not fully explored in this case. The authors advocate multi-disciplinary, large-scale and international studies for early recognition, safer imaging modalities to visualize the entity of mineralizing microangiopathy and in-depth pathological understanding of this potentially devastating condition.

Disclosure/conflict of interest declaration

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