A 9 year-old young man was brought to the Emergency Department because he was “walking like he was drunk”, with speech difficulties and illegible handwriting. The child had had these symptoms for over two days, and his pediatrician had obtained a plain brain CT, which was interpreted as negative. He denied any headache or visual changes.

The child had fallen while riding his bike 12 days earlier, landing on his face, without LOC, as witnessed by his siblings. His mother saw him 30 minutes later, and noted him to be “a little dazed”, but otherwise OK. He had amnesia to the event, and complained of a diffuse headache for three days following the accident. His history was otherwise not contributory.

On physical exam, he had some resolving abrasions and ecchymosis of the right malar eminence. Although he comprehended speech adequately, his own speech was sparse. He had diffuse weakness (4/5) of all extremities, and slightly hyperreflexia on his R side, including a positive Babinski’s reflex on the R. He was noted to have cerebellar ataxia as noted on finger-to-nose and heel-to-shin movements of the R extremities. He had a moderately ataxic gait in the ED, especially with heel-to-toe walking.

What is your differential diagnosis and how would you proceed?
Non-hemorrhagic Pontine Infarct in a Child After Mild Head Trauma: An Update in 2002

Enclosed is a copy of a case report from Academic Emergency Medicine, published in 1995. What follows are a summary of the key concepts regarding pediatric stroke, especially post-traumatic non-hemorrhagic infarcts, as well as new references that supplement this previously published case report. Thanks to Dr. Ross Tannebaum, who collected the excellent materials for this case presentation.

Background, Risk Factors, and Epidemiology

The occurrence of ischemic stroke in pediatric patients after minor head injury, although uncommon, has been reported in many case reports and case series. The ischemic stroke seen with minor head trauma will most often occur in the distribution of the middle cerebral artery, and will include the basal ganglia.

Since the publication of this case report in 1994, there have been multiple publications that address etiologies of pediatric stroke. These include spontaneous carotid and vertebral artery dissection, traumatic vertebral artery dissection, cerebral venous and sinovenous thrombosis, cardiac valvular tumor with embolization, dilated cardiomyopathy, and plasma-phase risk factors.

More information regarding the epidemiology of pediatric stroke is available in the report from the NINDS workshop on perinatal and childhood stroke.

Clinical Presentation

In many cases, the head injury seen prior to an ischemic stroke can be minor and can have occurred more than 24 hours prior to the onset of symptoms. Children often will present with hemiparesis, speech abnormalities, and cerebellar findings, as do adults with ischemic stroke. In one series, children with minor head injury presented with transient blindness without prolonged loss of consciousness or CT findings consistent with a CNS injury.

ED Diagnosis

Non-infused brain CT is the best first step in the ED diagnosis of pediatric stroke, since it is most sensitive in detecting small areas of hemorrhage with or without prior head injury. MRI is useful in detecting lesions which are not detected by CT, and should be utilized as soon as is feasible after the time of ED presentation. MR angiography increases the diagnostic yield, in that it will detect vascular congenital abnormalities and the presence of acute vascular injuries, such as acute vessel dissection. In the setting of suspected intentional pediatric head injury, diffusion-weighted imaging (DWI) is believed to provide the best indicator of brain injury, allowing for the best assessment of risk and the optimal treatment strategy.
In-Hospital Evaluation

Once admitted, the child with an ischemic stroke needs to be evaluated for other etiologies besides head injury. CNS vascular abnormalities and diseases such as moyamoya occlusive disease must be excluded via angiography if an MRA has not been completed. Vasculitides such as homocystinuria and collagen vascular diseases must be ruled out. Infectious etiologies such as meningitis and encephalitis must be excluded via lumbar puncture, and other infections such as neurosyphilis and Lyme disease must also be excluded. Cyanotic congenital and rheumatic valvular disease must be excluded via echocardiogram. Hypoercoagulable states such as sickle cell disease, lipid disorders and lymphoproliferative malignancies must also be ruled out. Lastly, demyelinating diseases such as multiple sclerosis and Schilder’s disease must be excluded through lab testing and the use of MRI.\textsuperscript{21,22} When all of these alternate diagnoses have been excluded and there has been no antecedent head injury, the diagnosis of “idiopathic non-hemorrhagic infarct” must be entertained.

Ongoing Stroke Therapy

A German study published in 2001 suggests that in pediatric stroke patients, aspirin therapy is as good as low molecular weight heparin (LMWH) in preventing recurrent strokes.\textsuperscript{23} Up to 10% of patients in this series had a recurrent stroke, most often in the same vascular territory, and at a median time of five months.

Conclusions

Pediatric ischemic stroke can occur following relatively minor head injury. This history should always be elicited in evaluating a pediatric patient with a neurologic deficit. A CT scan without infusion is the best initial radiographic study. Because ischemic stroke can complicate minor head injury in a delayed fashion, all pediatric patients with minor head injury should be given head injury instructions upon discharge form the Emergency Department.
A 9 Year-old Who Was Walking “Like He Was Drunk”

Clinical Course and Outcome

The patient was admitted to the pediatric service for a full evaluation of his R hemiparesis. Metabolic testing was negative, as was his lumbar puncture, tests for collagen vascular diseases, Hb electrophoresis, and echocardiography. Cerebral angiography was also normal.

The T1 MRI showed an isodense pons. The T2 MRI revealed a solitary hyperdense lesion of the medial L pons, consistent with a non-hemorrhagic infarct n the distribution of the paramedian branch of the basilar artery, a vessel not normally demonstrated on cerebral angiography.

This child’s L medial pons infarction corresponded to the distribution of the paramedian branch of the basilar artery. Infarction of this vessel causes contralateral hemiplegia or hemiparesis, often with ataxia. This injury is theorized to occur as a result of shearing or stretching forces, which cause intimal injury and delayed dissection and infarction.

The patient improved over his eight day hospital stay without any specific therapeutic interventions. He was discharged with a slightly ataxic gait, but improved speech and motor function. One month later, his neurologic exam was intact.

Four months later, the T1 MRI showed a hypodense pons lesion, and the T2 MRI revealed a resolving hyperdense lesion in the same location, consistent with a resolving non-hemorrhagic infarct. (Please see the published case reports for the actual MRI prints.)
A 9 Year-old Who Was Walking “Like He Was Drunk”

Reference List


Annotated Bibliography


   This is the published case report of this patient. It is current as of 1994, and summarizes all of the information available regarding this disease state up until that date. It includes the MRI findings from both the acute setting and at four month follow-up.


   This is a case series of 23 children under the age of 6 ½ years who developed unilateral weakness after apparently minor blunt head trauma. All 23 were noted to have a hypodense lesion in the basal ganglia, consistent with an ischemic infarct. Only three children were noted to have any altered level of consciousness, and this resolved within hours of the minor injury. Despite the persistence of the lesion on CT, all but one child had complete resolution of their symptoms within four months of the time of injury.


   This is a case series of 75 patients who presented with a stroke. 80% were noted to be ischemic, and trauma was thought to be the predisposing factor in 22% of the cases. This series is somewhat limited in that the majority of patients were between the ages of 26 and 45 years.


   This is an older series of 17 cases of internal carotid occlusion, which demonstrated that 20% of the cases were associated with prior trauma. In 30% of these trauma-related cases, the trauma had occurred greater than 24 hours prior to the onset of symptoms. This series also included the precipitating factors for the 107 previously published cases of internal carotid artery occlusion.


   This is a series of stroke patient between the ages of 16 and 40 years. In it, ischemic stroke associated with vessel occlusion was thought to be associated with antecedent head trauma in 5% of the patients.

This is a series of pediatric patients 10 months to 10 years of age with basal ganglia injuries following relatively minor head trauma. In all seven cases, there were only slight scalp wounds and no skull fracture, despite the finding of unilateral basal ganglia infarction on CT.


This is a case series of 54 children up to age 15 with a diagnosis of cerebral infarction from Japan. Minor head trauma and infectious causes were noted to be more common that heart disease is causing these ischemic strokes. The middle cerebral artery and its region of distribution, including the basal ganglia, was the most commonly affected area, with patients most commonly presenting with hemiparesis.


This is the report of the NINDS workshop on perinatal and childhood stroke. If you need and article that covers epidemiology, animal models, risk factors, outcome, prognosis, and areas of future research, this is the one. The group recommends the formation of a pediatric stroke registry to collect more data on this important subject.


This is an article that covers the topic of MRI in pediatric stroke. The author suggests that with the proper work-up, the etiology can be determined in up to 75% of pediatric stroke patients. He states that cardiac disorders and hemoglobinopathies are the most common causes of ischemic infarction, and congenital abnormalities and bleeding disorders are most often seen in pediatric hemorrhagic stroke.
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Questions

1. The most common cause of ischemic stroke in children and young adults is:
   a. Aneurysm
   b. Arteriovenous malformation
   c. Trauma
   d. Cardiovascular disorders

2. The most common presentation of a pediatric ischemic stroke is:
   a. Hemiparesis
   b. Generalized seizure
   c. Coma
   d. Aphasia

3. The most common anatomic location for a pediatric ischemic stroke is:
   a. Anterior cerebral artery
   b. Vertebral artery
   c. Posterior cerebral artery
   d. Middle cerebral artery

4. All of the following are true of post-traumatic pediatric ischemic stroke except:
   a. The onset of symptoms can often be greater than 24 hours after the trauma.
   b. The CT obtained in the ED often can be negative, requiring MRI testing.
   c. The physical trauma associated with this syndrome is most often significant.
   d. Most children will have resolution of their symptoms within four months.

5. The EM physician should consider all of the following in pediatric ischemic stroke except:
   a. Inquire about prior minor head trauma when stroke is observed in the ED.
   b. CT is preferred over MRI acutely, in that it is most sensitive in detecting hemorrhage.
   c. Head injury instructions must be given, regardless of how “minor” the head trauma
   d. The work-up for pediatric stroke patients is similar to that of adult stroke patients.
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Answers

1. Answer c.

The most common single cause of ischemic stroke in children and young adults in many cases series is the occurrence of prior head injury. Causes of hemorrhagic stroke, such as arteriovenous malformations and aneurysmal rupture, do not cause ischemic stroke in children.

2. Answer a.

The most common presentation of an ischemic stroke in children is hemiparesis. The other presentations are far less commonly seen.

3. Answer d.

The middle cerebral artery and its distribution, including the basal ganglia, is the most common site of vascular occlusion and ischemic stroke.

4. Answer c.

The physical findings associated with post-traumatic pediatric ischemic stroke most often is not significant; in fact, often there is minimal soft tissue injury and no skull fracture seen.

5. Answer e.

Because advanced vascular disease is not present in pediatric patients, there is the need to complete a more extensive work-up in order to determine the etiology of the stroke in children as opposed to adults.