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Case reports

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DIFFERENTIATING STROKE, TRANSIENT ISCHEMIC ATTACK, OR HEMIPLEGIC MIGRAINE IN A TEENAGER: A CASE REPORT

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A – study design, **B** – data collection, **C** – statistical analysis, **D** – interpretation of data, **E** – manuscript preparation, **F** – literature review, **G** – sourcing of funding

ABSTRACT

Background: The symptoms of stroke in the pediatric population are less evaluated than in adults. Although certain indicators are characteristic of stroke – acute drooping of the mouth corners, hemiparesis, and headache – they are not pathognomonic. Other diseases may manifest with similar symptoms, such as the first episode of hemiplegic migraine, and should be differentiated from stroke at an emergency department.

Aim of the study: We present the differential diagnosis between stroke, transient ischemic attack, and first episode of hemiplegic migraine in a teenager with alarming focal symptoms.

Case report: We present a case of 15-year-old patient with acute headache, drooping of the right mouth corners, and hemiparesis of the right upper and lower limb. He was brought by ambulance to the emergency department under suspicion of a stroke. A series of diagnostic tests performed at the Emergency Department did not reveal any vascular incident. Further diagnosis was performed at the Neurology Department. The patient was discharged from the hospital with a suspicion of first attack of hemiplegic migraine or transient ischemic attack.

Conclusions: Differentiating stroke from other conditions in young patients is a significant challenge. The stroke diagnostic process in children requires further research to support accurate diagnosis and, if necessary, treatment as rapidly as possible.

KEYWORDS: pediatrics, hospital emergency service, migraine disorders, stroke

Background

Pediatric stroke is a rare diagnosis, affecting 1.3–13 per 100,000 children [1-3]. Nevertheless, it is among the top 10 of causes of death among children (3.3–10% of affected children die [1, 3, 4]). Moreover, survivors may experience lifelong disabilities [5]. Up to 24.7% of patients had moderate to severe neurological impairment for two years after childhood ischemic stroke according to a study by Felling *et al.* [4]. Stroke can affect motor, cognitive, and behavioral function [6]. The number of pediatric patients with stroke is constantly increasing (35% increase in cases in the period 1990 to 2013 [5]), due to higher survival of children with risk factors and better diagnostic methods [2]. While the common etiology of stroke in adults is long-term acquired cardiovascular disease, in children it may be infection, hematologic pathologies, neoplasm, vascular abnormalities (mainly hemorrhagic stroke), or toxins [1]. However, coexisting conditions as risk factors are present in only 30% of pediatric ischemic stroke and 29% of hemorrhagic stroke cases [6]. The most common risk factors for ischemic stroke are congenital heart disease, head trauma, meningitis or encephalitis, sepsis, and sickle-cell disease [6]; for hemorrhagic stroke, they are congenital heart disease, arteriovenous malformations, and sepsis [6]. Pediatric

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stroke affects boys more often and the median age is 8.4 years at the time of diagnosis [1, 6]. It is crucial to diagnose stroke as rapidly as possible to enable time-limited reperfusion therapies [5].

Transient ischemic attack (TIA) is rarely described in children [7]. The definition of TIA recently changed from a self-resolving focal cerebral ischemia with symptoms lasting < 24 h to transient neurological deficits of any duration with no evidence of acute brain tissue infarction [8]. Impairment after TIA, such as as cognitive deficits, fatigue, inability to generate quick and accurate voluntary movements, and abnormal gait, may persist for a long time after symptom resolution [8]. In an analysis by Adil *et al.* [7], TIA was associated with sickle cell disease (about 20% of cases), migraine (about 12% of cases), congenital heart disease (about 11% of cases), moyamoya disease, and stroke. In < 6% children affected by stroke, comorbidities such as anemia, coagulopathy, diabetes, hypertension, and obesity were present [7]. However, TIA with the identified risk factors is observed in only 60% of pediatric cases of this condition [7].

Clinical differentiation of stroke from its mimics is the first step of diagnosis. The most common childhood stroke mimic is migraine with aura, followed by seizure and infections of the brain [3,9]. According to a retrospective study by Toldo *et al.* [10], the mean age of onset of hemiplegic migraine (HM) was 10.5±3.8 years. Typical onset occurs in the second decade of life, but can occur in people ranging from 1–45 years [11]. The first episode should be differentiated from other plausible conditions such as stroke, mass lesions, metabolic disturbances, demyelinating disease, infection, and inflammatory diseases [11, 12].

The Recognition of Stroke in the Emergency Room (ROSIER) and Cincinnati Prehospital Stroke Scale (CPSS) are widely used by first-line healthcare providers to estimate the probability of acute stroke in adults; however, they are less accurate in children [13]. These tools are specific to ischemic stroke. In children, hemorrhagic stroke is responsible for higher percent of vascular incidents [13].

Aim of the study

This study presents the differential diagnosis between stroke, TIA, and first episode of HM in a teenage patient with alarming focal symptoms.

Material and methods

Data for this case report were collected on the basis of medical records from the Pediatric Teaching Clinical Hospital University Clinical Centre of the Medical University of Warsaw. The appropriate consent was obtained from the Director of the Hospital. The study followed the provisions of the Polish Act on Patient Rights and the Patient's Rights Ombudsman. In accordance with the Helsinki Declaration, the case report was fully anonymized and none of the data could be used to identify the patient. Photos are not presented to increase the degree of anonymity. The presentation of this case does not require the consent of the Bioethics Committee, in accordance with the requirements of Polish law.

Case report

Patient information

A 15-year-old boy was brought to the Emergency Department by Emergency Medical Service ambulance with headache, drooping of the right mouth corners, and hemiplegia of the right side of the body. A few hours earlier at school he reported scotoma and a headache 6/10 on the Numeric Rating Scale (NRS). He had received ibuprofen from a school nurse and thiethylperazine from the paramedics. He had nausea and vomited twice. He reported a tingling sensation and numbness in his right upper limb. The family history revealed that his father had high blood pressure diagnosed at the age of 32 and that his mother suffered from migraine with aura. The grandfather on the patient's dad's side died of stroke at age 69 and the grandmother on the mother's side died suddenly at age 48.

Clinical findings

On admission to the Emergency Department of the Pediatric Teaching Clinical Hospital University Clinical Centre of the Medical University of Warsaw, the patient reported a headache with a NRS score of 5/10 in NRS in the frontal region. He denied photophobia and dizziness. Physical examination revealed central paresis of VII nerve, speech impediment, aphasia (a problem with finding proper words), temporal confusion, hemiparesis of upper and lower right limbs, a positive Babinski's sign on the right side, and negative meningeal symptoms. The peripheral lymph nodes were in normal size. In auscultation normal heart beating and breathing sounds. The liver and spleen were not enlarged. The patient's skin showed no pathological changes, his body temperature was 37 °C, blood pressure was 127/81, heart rate was 74, oxygen saturation was 100%, and capillary return was < 2 s. Fifteen minutes after examination, the patient's focal symptoms (drooping mouth corners, hemiplegia) subsided. During neurological examina-

tion 2 h after admission, the patient was conscious and oriented, but with temporary confusion, and received 15 points on the Glasgow Coma Scale (GCS). The patient's pupils were circular, reactive, and with slight asymmetry – the right pupil was wider than the left one. Sensation of the skin of the face was preserved and symmetrical. Symmetry of face muscles during movement and at rest was observed. The palatal arch tension was proper, the uvula was in the middle, and the tongue was normal. Slight asymmetry of muscle strength was present, with low muscle tone in the distant parts of the right upper and lower limbs. The finger-to-nose test was without pathology, the knee reflex was normal on the left side and negative on the right side, and the Achilles tendon reflex was stronger on the left side. The heel-to-knee test was bilaterally negative. The station test was negative. Free gait was normal. The patient could stand on their tiptoes and on their heels, but with difficulty on the right leg. Babinski's sign was bilaterally negative. Tension and sensation were preserved.

Timeline

The patient reported that incidents of headaches had occurred before, with a recent frequency of once per week, but with no need for analgesics. There were two incidents of stronger headaches with vomiting in the last month, but without focal symptoms. The patient did not connect the headaches with exertion or emotional stress. He did not suffer from any chronic disease.

Diagnostic assessment

Computed tomography (CT) without contrast was performed and revealed brain without any focal changes, no displacement of central structures, no evidence of fresh intracranial hemorrhage, and a symmetric ventricular system that was not extended. Coagulation test results were normal. On electrocardiography (ECG), the sinus rhythm was 68–85/minute, indicating sinus arrhythmia. Intraventricular conduction disturbances in V1 were observed. After cardiological consultation, it was qualified as a variant of the norm. In the evening on the day of admission, there was improvement in the patient's general state and reduced headache. On neurological examination, there was a lack of symptoms without focal damage of the brain. Deep tendon reflexes were present and symmetric.

A panel of diagnostic tests was ordered in order to exclude stroke and the patient was admitted to the Neurological Department. Laboratory tests were ordered, including Borrelia antibodies, ANA, ANCA, lipoprotein profile, TSH, fibrinogen, activity of protein C and S, homocysteine, genetic test for Leiden mutation, Ca, P, and vitamin D3. In addition, EEG, magnetic resonance imaging (angio–MRI), Doppler USG of carotid arteries, and chest X-ray were scheduled. MRI showed brain with no pathological changes, normal size ventricles, and no pathology in the intracranial arteries. Alert and sleeping EEG and Doppler USG of carotid arteries showed no pathological changes. On Doppler USG, the common carotid arteries, internal and external carotid arteries spectrum, and flow velocities were within the normal range. The vertebral arteries showed symmetrical, cephalic blood flow with a right diameter of 3.2 mm and a left diameter of 4 mm. The patient was discharged from the hospital with suspicion of HM or an episode of childhood TIA with motion sickness and referred to ambulatory neurological care for further investigation.

Therapeutic intervention

Ibuprofen was administered by a school nurse. The patient received 0.9% intravenous NaCl and 6.5 mg thiethylperazinum from the Emergency Medical Service paramedics. During the stay in the hospital, the patient received intravenous acetaminophen and 0.9% NaCl.

Follow-up and outcomes

All of the symptoms, including hemiparesis, headache, and nausea, subsided. Furthermore, CT, MRI, EEG, Doppler USG of carotid arteries, and laboratory tests showed no abnormalities. Follow-up was not assessed in this study.

Discussion

Our patient presented with alarming symptoms of stroke: rapid focal neurological deficit as hemiplegia, speech disturbances, and headache [2, 5]. In the neonatal period, seizures are the most common presentation of ischemic stroke, while in older children – hemiparesis [4]. Hemiparesis was present in 90% of childhood stroke cases in an analysis by Bonfert *et al.* [3]. The first diagnostic step is to exclude stroke. CT is the test of first choice in the Emergency Department and should be performed within 1 hour, in accordance with the 2017 UK Guidelines for suspicion of stroke [14]. However, CT has poor sensitivity for early ischemic infarction, which is why the patient was referred for MRI [5]. Investigation of the etiology of the stoke is important, mostly to prevent recurrence in the future. It is crucial to perform vascular imaging

(e.g., MRI) to find possible malformations or rule out vasculitis or moyamoya disease [12]. For our patient, the onset of congenital heart disease was unlikely at the age of 15; nevertheless, ECG was performed and revealed no pathology. Blood morphology enabled us to exclude leucostasis in leukemia or infection (in children associated with strokes are acute varicella and herpes simplex infection [5]). Prothrombotic factors, including Factor V Leiden, prothrombin, lipoprotein a, protein C deficiency, and antiphospholipid antibodies, were controlled as a probable risk factor in ischemic stroke [2, 5]. Differentiating strokes from mimics has been well evaluated in adults; however, in children there is a need for further research. In a multivariable logistic regression model by Mackay *et al.* [9], arm weakness was the neurological sign with the higher odds ratio of stroke, but with wide (95%) confidence intervals. Other symptoms associated with increased odds ratio were being well the week before diagnosis, inability to walk, face weakness, and speech disturbance [9]. In pediatric populations, seizures and loss of consciousness are not independently associated with diagnosis of mimics – seizures are present in 11–52% of ischemic stroke cases and about 37–41% of hemorrhage stroke cases [9]. Visual symptoms, as presented by our patient, are not independently associated with stroke diagnosis, but may also indicate aura in migraine [9]. Aura affects 0.25 –0.33% of patients with migraine diagnosis [11, 12]. Aura in a migraine is classified as 'prolonged' when the duration is longer than 1 h but less than 7 days, and 'persistent' when lasting more than 7 days [12]. In the present case, the symptoms of suspected aura lasted for about 10 h. HM is a rare subtype of migraine that occurs in sporadic, familial, and inherited autosomal dominant forms. HM is characterized by motor aura – hemiparesis or motor weakness, or by non–motor aura symptoms such as visual, aphasic, and basilar type/brainstem symptoms, headache, photophobia, phonophobia, nausea, and vomiting [10]. There is a wide range of symptoms from pure HM to severe early-onset forms of recurrent comas, cerebral edema, or cerebellar ataxia [11]. Characteristic of different aura symptoms is slow progression over 20–30 min, typically beginning with visual symptoms followed by sensory, motor, aphasic, and basilar disturbances [11]. Visual symptoms can manifest as positive features, like flickering spots or zigzag lines, or as negative features like scotoma [11]. In the present case, scotoma was the only visual symptom; however, HM may also present in this way. Sensory symptoms combine positive features, such as pins and needles, pain, or a cold sensation, or negative symptoms such as numbness [11]. Our patient reported a tingling sensation and numbness of the right upper limb. Motor weakness typically starts in one hand and spreads to the arm and face, but can also spread to one whole side of the body [11], as in our case. The mean duration of motor aura is 3.5 h (range 5 min to 48 h) [10], and in our patient it was about 6 h. According to the International Classification of Headache Disorders III (ICHD III), the duration of motor aura should be <72 h and all aura symptoms should be fully reversible. Paraphasia or difficulty finding words impairs 52–66% of patients [11]. Our patient presented with temporal confusion and difficulty with finding proper words. HM can be sporadic or familial (in case of affected first-degree or second-degree relatives) [11]. Familial hemiplegic migraine (FHM) is divided into three subtypes based on underlying mutations in ion transportation genes: *CACNA1A* in FHM1, *ATP1A2* in FHM2, and *SCN1A* in FHM3. Sporadic cases can be caused by *de novo* mutations in these genes or by the inheritance of genetic mutations from a parent with no symptoms [11].

Our patient was discharged from the hospital with suspicion of first attack of HM or TIA, which did not present on CT or MRI imaging. The new definition of TIA is based on CT findings or, preferably, MRI scan, which better images TIA and minor strokes [3, 8]. When taking family history, it is crucial to ask about epilepsy, migraine, or hypercoagulability [12]. Adults with aura migraine have a higher risk of stroke than the general population; however, the risk is still low [12]. There are some differences in symptoms between HM and TIA, which are summarized in Table 1. In our patient, the symptoms progressed from visual to sensory and motor. The symptoms included positive sensory symptoms like tingling in the upper limb, which are more likely to suggest HM. However, this kind of headache and concomitant symptoms occurred for the first time and thus need to be observed in the future. CT and MRI scans revealed no vascular risk; however, this possibility should be further investigated.

Table 1. Differences in symptoms between hemiplegic migraine and transient ischemic incident [11, 12].

Feature compared	Hemiplegic migraine	Transient ischemic incident
symptoms	progressive and successive positive and negative symptoms	abrupt negative symptoms
headaches	occurring regularly	rare
vascular risk factors	absent	present

Limitations

The biggest limitation of this study is the lack of follow-up. Diagnosing a patient with either TIA or HM requires longer observation, as other incidents with similar symptoms in the future can help establish the diagnosis.

Conclusions

Pediatric stroke is rare condition; nevertheless, it should always be considered in patients with alarming symptoms. Although there are differences in the symptoms of stroke and hemiplegic migraine, the most important task in the Emergency Department is to exclude the most serious disorders. CT remains the mainstay of imaging in pediatric patients with stroke suspicion to exclude intracranial hemorrhage. Further diagnostics should include MRI and laboratory tests, depending on the clinical presentation of the patient and the pathologies considered in the differential diagnosis.

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