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НОВЫЙ ДЕНЬ В МЕДИЦИНЕ
NEW DAY IN MEDICINE**

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ndmuz@mail.ru

Тел: +99890 8061882

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EARLY DIAGNOSES OF PEDIATRIC STROKE

Jumaeva Maxliyo Jahongir qizi Email: Mahliyo992@gmail.com

Bukhara State Medical Institute named after Abu Ali ibn Sina, Uzbekistan, Bukhara, st. A. Navoi. 1
Tel: +998 (65) 223-00-50 e-mail: info@bsmi.uz

✓ *Resume*

Pediatric stroke is a medical emergency and should be treated rapidly to maximize favourable outcomes. Although there is paucity of data regarding morbidity and mortality because of delays in treating strokes in children, we know that this delay has ramifications on research into hyperacute stroke therapies such as thrombolysis or endovascular thrombectomy.

Purpose: This review provides a comprehensive overview of the characteristics and diagnosis of pediatric stroke, emphasizing the importance of early recognition and accurate assessment. Pediatric stroke is a complex condition with diverse etiologies, and its timely diagnosis is critical for initiating appropriate interventions and improving clinical outcomes.

Summary: Timely and accurate diagnosis of pediatric stroke remains a challenge due to its rarity and variability in clinical presentation, and to the presence of many mimic conditions. The integration of clinical evaluation, neuroimaging, and comorbidities analysis is crucial for achieving a precise diagnosis and guiding tailored treatment strategies for affected children.

Keywords: Child; Stroke; Hemorrhagic stroke; Ischemic stroke; Emergency service

PEDIATRIK INSULTNING ERTA DIAGNOSTIKASI

Jumaeva Maxliyo Jahongir qizi

Abu Ali ibn Sino nomidagi Buxoro davlat tibbiyot instituti, O'zbekiston, Buxoro, st. A. Navoiy. 1
Tel: +998 (65) 223-00-50 e-mail: info@bsmi.uz

✓ *Resume*

Pediatrik insult-bu shoshilinch tibbiy yordam va ijobiy natijalarni oshirish uchun tezda davolash kerak. Bolalarda insultni davolashda kechikishlar tufayli kasallanish va o'lim bilan bog'liq ma'lumotlarning kamligi mavjud bo'lsa-da, biz bilamizki, bu kechikish tromboliz yoki endovaskulyar trombektomiya kabi giperakut insult terapiyalari bo'yicha tadqiqotlarga ta'sir qiladi.

Maqsad: ushbu sharhda bolalar insultining xususiyatlari va diagnostikasi haqida to'liq ma'lumot berilgan bo'lib, erta tan olish va aniq baholash muhimligini ta'kidlaydi. Pediatrik insult turli xil etiologiyalarga ega bo'lgan murakkab holat bo'lib, uni o'z vaqtida tashxislash tegishli aralashuvlarni boshlash va klinik natijalarni yaxshilash uchun juda muhimdir.

Xulosa: Pediatrik insultni o'z vaqtida va aniq tashxislash uning noyoblighi va klinik ko'rinishdagi o'zgaruvchanligi va ko'plab mimik sharoitlar mavjudligi tufayli qiyin bo'lib qolmoqda. Klinik baholash, neyroimaging va qo'shma kasalliklarni tahlil qilishning integratsiyasi aniq tashxis qo'yish va ta'sirlangan bolalar uchun maxsus davolash strategiyalarini boshqarish uchun juda muhimdir.

Kalit so'zlar: bola; insult; gemorragik insult; ishemik insult; shoshilinch xizmat

РАННЯЯ ДИАГНОСТИКА ДЕТСКОГО ИНСУЛЬТА

Джумаева Махлиё Джахонгировна

Бухарский государственный медицинский институт имени Абу Али ибн Сины, Узбекистан, г. Бухара, ул. А. Навои. 1 Тел: +998 (65) 223-00-50 e-mail: info@bsmi.uz

✓ **Резюме**

Детский инсульт - это неотложная медицинская помощь, и его следует лечить быстро, чтобы добиться максимально благоприятных результатов. Несмотря на нехватку данных о заболеваемости и смертности из-за задержек в лечении инсультов у детей, мы знаем, что эта задержка оказывает влияние на исследования в области лечения острого инсульта, такие как тромболизис или эндоваскулярная тромбэктомия.

Цель: В этом обзоре представлен всесторонний обзор характеристик и диагностики детского инсульта, подчеркивается важность раннего распознавания и точной оценки. Детский инсульт - это сложное заболевание с разнообразной этиологией, и его своевременная диагностика имеет решающее значение для начала соответствующих вмешательств и улучшения клинических результатов.

Резюме: Своевременная и точная диагностика детского инсульта остается сложной задачей из-за его редкости и вариабельности клинических проявлений, а также из-за наличия множества сопутствующих заболеваний. Интеграция результатов клинической оценки, нейровизуализации и анализа сопутствующих заболеваний имеет решающее значение для постановки точного диагноза и определения индивидуальной стратегии лечения пострадавших детей.

Ключевые слова: Ребенок; Инсульт; Геморрагический инсульт; ишемический инсульт; Служба неотложной помощи

Relevance

Pediatric stroke is a medical condition with profound implications for affected children and their families. It is characterized by the interruption of the blood supply to a portion of the brain during the perinatal period or childhood, leading to neurological deficits and potential long-term disabilities.

As with adults, strokes can be ischemic or hemorrhagic, though a larger proportion are hemorrhagic strokes (HS) in children. Common etiologies for adults are atherosclerosis or hypertension. In contrast, pediatric stroke etiologies are wider, ranging from arteriopathy, cardiac, prothrombotic disease and other systemic conditions in arterial ischemic strokes (AIS) [6], to arteriovenous malformations, hematologic disorders, and brain tumors in HS [7,8]. Recognizing acute strokes in children requires a high index of suspicion. Presentation of pediatric stroke is protean and differential diagnoses for stroke-like symptoms in children is broad. Younger children tend to present with non-specific symptoms such as seizures or altered mental state, and older children with focal neurological deficits.

Therapeutic strategies for pediatric stroke require a multidisciplinary approach, involving medical management, rehabilitation, and supportive care. Early intervention is crucial for salvaging brain tissue and minimizing long-term sequelae, and rehabilitation plays a pivotal role in maximizing functional recovery and optimizing the quality of life for affected children.

In recent years, innovative techniques such as brain-computer interfaces, mirror-mediated therapy, stem cell therapy, and non-invasive brain stimulation have shown promise in enhancing motor function and neurorehabilitation outcomes in pediatric stroke. These emerging therapies highlight the potential for novel approaches to optimize functional recovery and neuroplasticity in this vulnerable population.

Pediatric stroke is a medical emergency and should be treated rapidly to maximize favourable outcomes [13]. Although there is paucity of data regarding morbidity and mortality because of delays in treating strokes in children, we know that this delay has ramifications on research into hyperacute stroke therapies such as thrombolysis or endovascular thrombectomy [14]. The Thrombolysis in Pediatric Stroke (TIPS) trial had to close early as most strokes were not identified within the therapeutic window, and there were greater risks than benefits of treatment [15].

Purpose: This review provides a comprehensive overview of the characteristics and diagnosis of pediatric stroke, emphasizing the importance of early recognition and accurate assessment. Pediatric stroke is a complex condition with diverse etiologies, and its timely diagnosis is critical for initiating appropriate interventions and improving clinical outcomes.

Materials and methods

AIS is defined as presence of neurological deficit consistent with ischemia in an arterial distribution, or acute non-localizing encephalopathy (including symptomatic new-onset seizures), with confirmation of infarction on imaging or autopsy, occurring in a person between 29 days through 18 years of life [17]. HS is defined as atraumatic abrupt onset of severe headache, altered level of consciousness and/or focal neurologic

deficit associated with bleeding into the brain by a ruptured blood vessel. This results in focal collection of blood within the brain on imaging not due to trauma or hemorrhagic conversion of cerebral infarction. HS includes intracerebral hemorrhage (ICH), intraventricular hemorrhage, or subarachnoid hemorrhage [7,18]. Exclusion criteria were traumatic brain injuries, transient ischemic attacks, perinatal strokes, metabolic infarction in a nonvascular territory (such as Mitochondrial Encephalopathy, Lactic Acidosis and Stroke-like episodes [MELAS]), hypotensive watershed injury, periventricular leukomalacia, cerebral venous sinus thrombosis or reversible hypertensive leukoencephalopathy [9]. Descriptive statistics were used for baseline characteristics and clinical presentations. Continuous variables were described using mean (with standard deviation), or median (with interquartile range [IQR]), depending on normality. If exact timing was not available, duration from symptom onset to ED presentation were estimated based on documentation in clinical notes rounded up to nearest hour. Categorical variables were analyzed using Fisher's exact test and continuous variables using Student's t-test or Wilcoxon rank sum, depending on normality. Univariate regression analyses were performed to identify factors associated with diagnosis after admission. Variables with $P < 0.1$ in univariate analysis were included in a multivariate logistic regression model to identify independent predictors. Statistical significance was taken at $P < 0.05$. All point estimates were presented with corresponding 95% confidence intervals (CIs).

Results and discussions

Patients with AIS presented less frequently with non-specific signs and symptoms such as headache, vomiting and lethargy, compared to HS. Fewer AIS patients were admitted to the intensive care unit (2/11 [18.2%] vs. 10/25 [40.0%] HS, $P = 0.005$). No AIS patients required intubation, while 6/25 (24.0%) of HS patients were intubated in ED (four for GCS < 8 , one for respiratory distress) ($P = 0.295$). No patients demised in ED. One HS patient demised as an inpatient. Median time from symptom onset to ED presentation was 24.0 hours (IQR, 12 to 28) for AIS and 7.0 hours (IQR, 1.8 to 48) for HS ($P = 0.595$). Only 2/11 (18.2%) of AIS and 12/25 (48.0%) of HS patients presented within 6 hours ($P = 0.142$). Majority of patients were conveyed to hospital via own transport rather than ambulance: 9/11 (81.8%) AIS and 20/25 (80.0%) HS ($P = 1.000$). Among 28 patients with at least 1 year follow-up (Table 1), more than half had at least one residual neurological deficit: 4/8 (50.0%) for AIS and 11/20 (55.0%) for HS. Children with AIS had predominantly motor deficits (5/8, 62.5%) while HS patients suffered limitations including speech difficulties, epilepsy and cognitive and behavioral impairment.

Table 1

Outcome measures of pediatric stroke patients (n=28a)

Outcome measure	Arterial ischemic stroke (n=8)	Hemorrhagic stroke (n=20)	P value
At least one new neurological deficit	4 (50.0)	12 (60.0)	1.000
Motor sequelae	5 (62.5)	7 (35.0)	0.231
Cognitive impairment	2 (25.0)	5 (25.0)	1.000
Speech difficulties	1 (12.5)	7 (36.8)	0.364
Swallowing difficulties	0	1 (5.3)	1.000
Epilepsy	1 (12.5)	3 (15.0)	1.000
Behavioral disturbances	1 (12.5)	4 (20.0)	1.000

Values are presented as number (%).

Patients with at least 1 year of follow-up, based on the latest relevant follow-up appointment, were included. Children with AIS received anti-thrombotic (7/11, 63.6%) and anticoagulation (5/11, 45.5%) therapy.

Patients with known hematological disease were more likely to have residual deficits (4/4, 100%) ($P = 0.113$). Patients with residual neurological deficits had lower time of symptom onset and time of ED presentation to diagnosis on neuroimaging. Generally, younger infants presented with symptoms such as poor feeding, crying, vomiting, and aspiration symptoms. They were mostly initially diagnosed as respiratory tract infections or viral illnesses. Older children presented with symptoms such as headache, neck pain or vomiting, and were commonly diagnosed as secondary headaches due to viral illnesses or musculoskeletal pain.

Conclusion

Presenting features varied according to stroke type; focal features were more common in AIS, as in other studies [11,16]. Our data showed that 35.3% presented with focal features and 31.5% with hemiparesis, lower

than Mallick et al's [11] study, in which 83% presented with focal features and 71% with hemiparesis.

Pre-hospital delay from time of symptom onset to ED presentation is the largest barrier to pediatric stroke care here. It is important for early stroke interventions. Such as neuroprotective measures to maintain cerebral perfusion, normoglycemia, or expedient early surgical decompression in HS [9]. Our median time of symptom onset to ED presentation is 24 hours for AIS and 7 hours for HS, suggesting delayed caregiver recognition. Furthermore, less than 20% were transported via ambulance, suggesting it was not identified as emergency by most parents. Pediatric ED physicians play a critical role in early diagnosis. Studies of pediatric thrombolytic therapy suggested that risks outweigh benefits [15].

Around one third of our patients did not have stroke as a clear differential diagnosis, largely due to non-specific symptoms and absence of focal neurological deficits. A higher proportion were HS (35.0% HS vs. 17.8% AIS) and nearly half were infants. HS patients can have decreased GCS, non-specific symptoms of headache, vomiting, and even neck pain. Interestingly, two patients (age 10 and 15) with HS presented with headache and neck pain.

Nevertheless, appropriate treatment should still be commenced. In our cohort, two AIS patients had negative CT scans performed at ED. CT brain was performed for 2 hours acute onset of left sided weakness, and for seizure with right hemiplegia lasting 1 hour. They were eventually diagnosed with AIS due to CNS vasculitis and cardioembolism respectively. Appropriate treatment of intravenous hydration and neuroprotective measures was still started regardless of MRI scan timing and findings. After MRI, further treatment with enoxaparin for CNS vasculitis and heparin for cardioembolism was commenced.

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