Original article

Validity of Neuroimaging in Juvenile Headaches

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Abstract

Aim: The objectives of this study are to evaluate the incidence of headache considering the type of headache, to define the types of headaches, to determine the difference in the status of diagnostic scanning in children with headaches, to establish a correlation between the psychological profile of the child and the incidence of headache, and to establish a correlation between socio-demographic characteristics and the type of headache.

Patients and Methods: The study included 139 patients with headache symptoms up to the age of 18, hospitalized at the Pediatric Clinic of the University Hospital Center Osijek from 1/1/2017 to 31/12/2018. The data included demographic data, diagnosis, environmental factors, EEG findings, neuroimaging data processing and other indicated medical tests.

Results: A headache usually occurs between the ages of 12 and 18 (69.8%). It is more common in girls (70.5%). The common localizations are frontal and occipital. Altered standard EEG findings were reported in 26.7% of patients. Additional neuroradiological processing (brain MRI) was indicated in 98 patients (70.5%), with changes found in 56 patients (57.1%). Psychological assessment indicated that patients with functional headaches predominantly suffer from anxiety, emotional instability and somatization, while patients with organic headaches reported high stress levels (82%).

Conclusion: Headaches occur more frequently in pubescent girls. The most common concomitant symptoms include nausea and vomiting, while the most common localization is frontal. Patients also report emotional instability, cognitive deficits and somatization, as well as high stress levels. Headache as a result of psychological tension is the most common diagnosis in the observed group of patients.

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Introduction

A headache in childhood is not a rare symptom, regardless of whether the headache background is organic or functional. According to the experience of numerous authors, childhood headache is most commonly of organic origin (1). The headache is determined by localization (frontal, occipital, temporal), pain type (dull, pulsating pain), frequency, duration and associated symptoms and signs (2).

The incidence of headaches depends on age and gender, as well as on the type or category of headache. The prevalence of headaches of different types at the age of 7 is 31 51%, increasing to 57-82% at the age of 15 (3). In school children, the most common type are primary headaches, which are defined as headaches that are not associated with an underlying disorder (Group 1-4, according to the classification of the International Headache Society (IHS Classification)) and classified as migraines or tension-type headaches (TTH). The most common causes of secondary headaches are viral respiratory infections (29-39%) and mild head injuries (4, 5). Researchers have found that the incidence of migraine (except for migraine with aura) is similar in girls and boys, while tension-type headaches occur more often in girls, and that gender has some effect on IHS criteria for migraine, but it has almost no effect on those for tension-type headaches (6). Risk factors for headaches or chronic headaches are as follows: dysfunctional family situation, regular alcohol consumption, caffeine intake, smoking, low levels of physical activity, physical or emotional abuse, bullying, misconduct at school, and insufficient leisure time (4).

Each child with a headache requires an individual approach. The assessment of a child suffering from a headache begins with a thorough physical examination, including blood pressure measurement, a neurological examination and a meticulous medical history (3). If a child with recurrent headaches has a normal neurological status during the examination, it is not necessary to routinely (urgently) perform a neuroradiological assessment (brain CT or MRI). A neuroradiological assessment is certainly indicated for determining the cause of secondary headaches. Cerebrospinal fluid analysis is needed in febrile immunocompromised children with a headache due to suspected meningitis. It is not necessary to routinely perform electroencephalography (EEG) in the evaluation of children with headaches. EEG is indicated if epileptic seizure or a secondary headache (caused by a tumor, head trauma, encephalitis, intracranial hemorrhage or ischemia) is suspected. However, changes in EEG are in principle neither specific nor pathognomonic for specific causes of secondary headaches (7).

The purpose of this study was to examine the types of headaches, the most common symptoms of headaches and their comorbidities, and to emphasize psychological examination in addition to the usual neurological treatment.

Patients and Methods

The study was conducted at the Pediatric Clinic of the University Hospital Center Osijek. The study included 139 pediatric patients diagnosed with headaches, hospitalized and treated between 1 January 2017 and 31 December 2018.

Data from the medical records and information system of the Pediatric Clinic included: age, sex, headache diagnosis, perinatal risk factors and psychomotor development of the child, child's admission status (clinical and neurological status), family history, data on the child's education and/or kindergarten attendance, child's psychological profile, EEG findings, neuroimaging processing, and other indicated tests.

Ethical approval for the study was obtained from Ethical Committee Faculty of Medicine University of Osijek and approval to conduct study was obtained from Clinical Hospital Centre Osijek.

Statistical analysis

The data collected were processed using statistical software R (version 3.3.2, www.r-project.org). Categorical data are descriptively represented by absolute and relative frequencies. Differences between categorical variables were examined using the $\chi 2$ test and the binominal test (23, 24). The level of statistical significance was determined as $p < 0.05$.

Results

The total number of hospitalized patients over the two observed years was 5554, of which 139 had headaches. Thus, the prevalence of hospitalization for patients with headaches was 2.5% with a 95% confidence interval of 2.11% to 2.95%. During the two observed years, there were no significant differences in the number of hospitalized patients ($p = 0.799$). In 2017, the number of hospitalized patients with headaches was 71, and in 2018, it was 68. A significant difference was found in the number of hospitalizations based on gender ($p < 0.001$). There was a significantly higher proportion of hospitalized female patients (70.5 %) in comparison to male patients (29.5%). When it comes to age, the highest prevalence of hospitalized patients was between the ages of 12 and 18 (69.78 %), followed by those between the ages of 5 and 12 (26.62 %), while only five patients were under the age of 5 (Table 1).

Table 1. Patients' demographic data

		n (%)	p*
Year	2017	71 (51.08)	0.799
	2018	68 (48.92)	
Gender	Male	41 (29.5)	< 0.001
	Female	98 (70.5)	
Age group	≤ 5	5 (3.6)	< 0.001
	5 to 12	37 (26.62)	
	12 to 18	97 (69.78)	

*χ^2 test

There was a significantly higher proportion of newly diagnosed headaches (59 %), $p = 0.034$. In regard to the number of hospitalizations, a significant number of patients were hospitalized more than once (58.7%). Functional headaches were reported in 41.01% of cases and organic headaches with comorbidities in 58.99% of cases ($p = 0.034$) (Table 2).

Table 2. Related characteristics of hospitalized patients with headaches

		n (%)	p*
Headache	Newly diagnosed	82 (58.99)	0.034
	Controlled	57 (41.01)	
Number of hospitalizations	1	57 (41.3)	0.041
	> 2	81 (58.7)	
Headache type	Functional	57 (41.01)	0.034
	Organic	82 (58.99)	

*χ^2 test

The highest number of patients complained of frontal headaches (40.29%), followed by occipital (17.27 %), parietal (13.67 %) and temporal (10.79 %) headaches. A lower number of patients suffered from headaches with multiple localizations: frontotemporal – 4.32 %, parieto-occipital – 2.16 % and diffuse – 3.6 % (Table 3).

Table 3. Headache localization

	n (%)	p*
Frontal	56 (40.29)	< 0.001
Parietal	19 (13.67)	
Occipital	24 (17.27)	
Temporal	15 (10.79)	
Frontotemporal	6 (4.32)	
Parieto-occipital	3 (2.16)	
Diffuse	5 (3.6)	

*χ^2 test

A statistically significant difference was found in the frequency of concomitant symptoms. Nausea and vomiting (44.85 %) are reported most frequently, followed by dizziness (33.09 %), loss

of consciousness (25.74 %), blurred vision (25 %), weakness and fatigue (17.65 %), tingling in hands (11.51 %). Tics are rarely reported as a concomitant symptom of headache (0.74 %) (Table 4).

Table 4. Concomitant symptoms of headaches

	n (%)	p*
Nausea and vomiting	61 (44.85)	< 0.001
Dizziness	45 (33.09)	
Loss of consciousness	35 (25.74)	
Blurred vision	34 (25)	
Febrility	6 (4.41)	
Tingling sensation in hands	16 (11.51)	
Absence seizure (petit mal)	5 (3.68)	
Photophobia	13 (9.56)	
Hand tremors	4 (2.94)	
Weakness and fatigue	24 (17.65)	
Tics	1 (0.74)	
Non-epileptic seizure	13 (9.56)	

*χ^2 test

There were 80 % of patients with normal laboratory findings (p = 0.003). There were 26.72 % of patients with altered standard EEG, as well as 31.76 % of patients who underwent partially sleep-deprived EEG. 5 0% of patients who underwent MR angiography of the brain had altered findings. 36.67 % of patients who underwent VEP testing had altered findings as well. There were 22.88 % of patients with altered ophthalmic findings and 46.43 % with altered ORL findings. Of all the patients who underwent an ECG, only one patient had altered findings, as well as pathologically changed continuous blood pressure monitoring. Two out of five patients had altered lumbar puncture findings and two out of 11 patients who underwent an initial CT scan reported changes (Table 5).

Table 5. Test results

		n (%)	p*
Laboratory data	Normal	20 (80)	0.003
	Altered	5 (20)	
EEG, standard	Normal	96 (73.28)	< 0.001
	Altered	35 (26.72)	
EEG, partially sleep-deprived	Normal	58 (68.24)	< 0.001
	Altered	27 (31.76)	
Brain MRI	Normal	42 (42.86)	0.669
	Altered	56 (57.14)	
MR angiography	Normal	3 (50)	> 0.999
	Altered	3 (50)	
VEP	Normal	19 (63.33)	0.144
	Altered	11 (36.67)	
Ophthalmic findings	Normal	91 (77.12)	< 0.001
	Altered	27 (22.88)	
ORL examination	Normal	15 (53.57)	0.706
	Altered	13 (46.43)	
ECG	Normal	34 (71.14)	< 0.001
	Altered	1 (2.86)	
Pressure Holter	Normal	3 (75)	0.317
	Altered	1 (25)	
Lumbar puncture	Normal	3 (60)	0.655
	Altered	2 (40)	
Head CT	Normal	9 (81.82)	0.035
	Altered	2 (18.18)	

* χ 2 test

Statistically significant differences were found in the incidence of headache types and particular categories of psychological disorders (p = 0.024). Significantly more disorders were reported in terms of emotional instability (15.15 %), cognitive deficits (15.15 %) and somatization (18.18 %) in functional headaches, while significantly higher levels of stress and similar conditions were

observed with organic headaches (82 %) (Table 6).

Table 6. Psychological disorder and headache type

	Functional n (%)	Organic	p*
Emotional instability	5 (15.15)	4 (8)	0.024
Cognitive deficits	5 (15.15)	3 (6)	
Stress	17 (51.52)	41 (82)	
Somatization	6 (18.18)	2 (4)	

* χ 2 test

Extremely difficult psychological conditions in children required a psychiatric consultative examination. 10.79 % of patients underwent psychiatric examination as part of headache treatment ($p < 0.001$) (Table 7).

Table 7. Reasons according to consultative psychiatric examination

	n (%)	p*
Extremely high depression level	1 (6.67)	0.395
In therapy because of suicidal thoughts and self-harm	2 (13.33)	
Pronounced symptoms of somatization disorders and anxiety-related disorders	1 (6.67)	
Organic origin of headache excluded; in psychiatric therapy until further notice	1 (6.67)	
Somatization headaches	2 (13.33)	
Outpatient treatment started	5 (33.33)	
In therapy because of bullying at school	1 (6.67)	
Identified PTSD symptoms due to loss of parent(s)	1 (6.67)	
Multiple hospitalizations	1 (6.67)	

* χ 2 test

A significant difference was found in the proportion of final headache diagnoses. Headaches as a consequence of psychological tension (26.62 %) account for the largest proportion (Table 8).

Table 8. Definitive headache diagnosis

	n (%)	p
Head trauma	8 (5.76)	< 0.001
SAH	2 (1.44)	
Tumor	0 (0)	
Sinusitis	13 (9.35)	
Acute infection	13 (9.35)	
Inflammatory CNS disease	1 (0.72)	
Cessation of AET intake	2 (1.44)	
Consequence of psychological tension	37 (26.62)	
Papillary edema of the optic nerve	5 (3.5)	

*χ2 test

Discussion

Headache is the most common neurological symptom and one of the most common childhood pains (8). According to the literature, the estimated incidence of recurrent headaches in children is about 80 %, with 10 % of them experiencing headaches more than 5 days a month, which negatively affects both the child and family. The most common types of childhood headaches are migraines and tension-type headaches. Studies have shown that learning disabilities have a high prevalence in children with primary headaches, especially migraines (8, 9).

This study found that headache symptoms were more common in female subjects, as was the case in the study by Wilcox et al. (10). Adolescent girls are more prone to developing headaches than boys, and consequently, they are at a higher risk of migraine or other primary headaches in young adulthood (11). The number of newly diagnosed headaches in 2017 was 71 (51.0 %), and in 2018, it was 68 (48.92 %). The number of hospitalizations indicates that a significantly high number of patients was hospitalized on more than one occasion (58.7 %).

Despite the high prevalence of headaches in the pediatric population, the characteristics of adolescent headaches remain unclear. Several studies have examined the age and gender-related differences in migraines and a few reported differences between children and adults, as well as between younger and older children. The onset of migraines in younger children is often in the form of cyclic vomiting or abdominal migraines, and is not accompanied by a headache, while in older children, more complicated migraines are accompanied by focal neurological symptoms. Due to the effect of hormones on the onset of migraines, migraines are 50% more likely to stop in males after adolescence (10, 12, 13).

The transition from childhood to adolescence is a sensitive and critical period for neurodevelopment, especially in the context of neurological disorders such as migraine (10). The mean age of onset of puberty is about 10 in girls and about 12 in boys (2). In this study, headaches were more common in puberty, in children over the age of 12, in 69.78 % of cases. Other studies confirm that migraine occurs in 3% to 10 % of children at puberty, increases with age and spontaneously withdraws after puberty in half of the children, but if it begins during adolescence, it is more likely to persist throughout adulthood (10, 12).

In this study, children complained of 7 different headache localizations. The most common localization was frontal, with 40.29 % of the patients reporting it. Somewhat less common were occipital 17.27 % and parietal 13.67 % headaches. An eight-year epidemiological study of unilateral headaches reported that unilateral primary headaches are more common in short-term headaches (<4 hours), but long-lasting headaches, including migraine, tension-type headache and new daily persistent headache, can also occur with pain on one side (14).

This study found that the most common side effects of headache were nausea and vomiting, which were reported by 61 subjects (44.85 %). Antonaci et al. reported that recurrent primary headaches can have a significant impact on the quality of life of children and adolescents due to the unpredictability of attacks and the presence of concomitant symptoms such as nausea, vomiting, photo- and/or phonophobia (5).

The most important diagnostic tools in the correct diagnosis of headache type are meticulous medical history, clear medical history and clinical examination. One of the key components is the distinction between primary and secondary headaches (15). Each patient admitted to the Pediatric Clinic with a headache, in addition to providing a detailed medical history and undergoing clinical and neurological examination, underwent complete neuroradiological assessment, ophthalmic and otorhinolaryngologic (ORL) examination. In this study, 57.14 % of patients had altered magnetic resonance imaging (brain MRI). The majority of the changes found were pineal gland cyst, vascular and gliotic lesions, and small demyelinating lesions. Altered standard EEG findings were present in 26.72 % of patients,

while 31.76 % of patients who underwent partially sleep-deprived EEG had altered findings as well. There were 6 (4.32 %) patients with clinical indications for additional neuroradiological processing (MR angiography), of which 3 (50 %) had pathological findings of the cerebral blood vessels. Based on advanced neurological processing, the indication for VEP was found in 30 (21.58 %) patients, 11 of whom (36.67 %) had pathological findings. There were 28 (20.14 %) patients with an indication for additional otorhinolaryngologic evaluation, 13 of whom (46.43 %) were diagnosed with sinusitis. Invasive neurological treatment, which included lumbar puncture, was indicated in 5 (3.59 %) patients, and after the procedure, the findings were altered in 2 (40 %) patients, 1 of whom was diagnosed with an inflammatory disease of the central nervous system. 11 (7.91 %) patients had an urgent indication for computed tomography of the brain (CT), 2 of whom (18.18 %) presented with abnormalities (intracranial hemorrhage).

All patients admitted to the Pediatric Clinic with anamnestic headache data were also subjected to psychological examination. Findings thereof were extremely important in defining some of the psychological difficulties, as well as environmental factors and living conditions of each child. More recent studies, such as this one, have emphasized the importance of recognizing psychosocial components in a child with a headache for elucidating the etiology thereof, but also in order to be able to access therapeutic procedures based on adequate psychological analysis. Events that greatly affect the incidence and type of headache include a range of family situations such as family conflicts and social problems, parental (un)employment, and economic hardships (16, 17).

Psychiatric disorders, especially depression, neurosis and anxiety, show significant comorbidity with migraine and are more common among people with chronic migraine compared with episodic migraine (18). In the group of children with functional headaches, more disorders were observed in terms of emotional instability (15.15%), cognitive deficits (15.15 %) and somatization (18.18 %), while in regard to organic headaches, there was a significantly higher level of stress and similar conditions (82 %). Of all the definitive diagnoses of headaches, headache as a result of psychological tension is the most common diagnosis (26.62 %).

Conclusion

This study aimed to research the incidence and frequency of headaches, to examine the correlation between comorbidity and the type of headache, and to examine whether there is a correlation between the psychological profiles of children at the time of onset of symptoms and the type of headache. This study confirmed that the highest proportion of definitive diagnoses of headaches were headaches that result from psychological tension. A smaller proportion are secondary headaches caused by inflammation of the central nervous system, sinusitis, trauma and subarachnoid hemorrhage. By preserving the mental health of children, we can prevent somatization, which is most common in puberty.

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