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THE USE OF NEUROIMAGING IN THE MANAGEMENT OF CHRONIC HEADACHE IN CHILDREN IN CLINICAL PRACTICE *VERSUS* CLINICAL PRACTICE GUIDELINES

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SUMMARY – In daily practice, neuroimaging studies are frequently performed for the management of childhood headache. The aim of this study was to determine whether there is significant discrepancy between clinical practice and clinical practice guidelines on the indications for neuroimaging studies. Medical records of children with chronic headache, aged 2 to 18 years and treated at Rijeka University Hospital Center, Kantrida Department of Pediatrics, were retrospectively reviewed. Indications for brain magnetic resonance imaging and computed tomography (MRI/CT) scanning were reviewed and compared with clinical practice guidelines. Brain imaging was performed in 164 (76.3%) of 215 children, MRI in 93 (56.7%) and CT in 71 (43.3%) children. Indications for brain MRI/CT were as follows: anxiety and/or insistence by the child's family (71.3%), presence of associated features suggesting neurologic dysfunction (13.4%), age under 5 years (12.8%) and abnormal neurologic examination (2.4%). The majority of children (71.4%) had normal neuroimaging findings. In the rest of imaging studies (28.1%), MRI/CT revealed different intracerebral/extracerebral findings not influencing changes in headache management. Only one (0.60%) patient required change in headache management after MRI/CT. Study results proved that, despite available evidence-based clinical guidelines, brain imaging in children with chronic headaches is overused, mostly in order to decrease anxiety of the family/patient.

Key words: *Children; Headache; Neuroimaging; Practice guidelines*

Introduction

Headache is the most common neurological disorder and a frequent complaint in children and adolescents. Epidemiological studies reveal different data on the incidence of childhood headaches depending on diagnostic criteria, studied population and study duration¹⁻³. However, most clinicians agree that the

prevalence of childhood headaches increases with age. According to some studies, it ranges from 37% to 51% in 7-year-olds, gradually increasing to 57% to 82% by the age of 15 years⁴⁻⁶. By the age of 16 years, more than 90% of all adolescents have already experienced at least one episode of intense headache⁷. Consequently, the management of children with headache makes a major component of daily pediatric practice.

Diagnosis of headache disorders in children rests mostly on clinical criteria as defined by the International Headache Society (IHS)⁸. Most children have primary headache disorders such as migraine or tension-type headaches^{1,9,10}. Secondary headache disorder

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ders, although much less common, can be due to various etiologies, which can range from relatively benign to life-threatening¹⁰.

Therefore, the accurate diagnosis of headache is crucial for successful management and treatment and represents a real challenge for everyday pediatric practice. For that reason, several clinical practice guidelines have been developed for the management of childhood headache¹¹⁻¹³. According to these, thorough medical history followed by methodical physical and neurological examination is considered sufficient to exclude the possible secondary causes of headache. Even so, neuroimaging studies, such as magnetic resonance imaging (MRI) and computed tomography (CT), are still frequently performed in children with headache¹⁴⁻¹⁷.

Hence, the purpose of our study was to determine whether there is significant discrepancy between clinical practice and clinical practice guidelines in the management of chronic headache in children, primarily considering indications for neuroimaging studies.

Subjects and Methods

Medical records of children admitted due to headache to the Rijeka University Hospital Center, Kantrida Clinical Department of Pediatrics, during the 2010-2013 period were retrospectively reviewed. All children were referred by a primary care pediatrician to a pediatric neurology outpatient clinic for additional evaluation. The study focused on children aged from 2 to 18 years with chronic headache defined as headaches present for at least 3 months and persisting for more than or equal to 15 days *per month*⁸. Children whose headache was associated with recent traumatic brain injury or who had previous diagnosis of hydrocephalus, significant neurodevelopmental disorder or neurocutaneous syndrome were excluded. Children diagnosed with any other type of headache were excluded from the study too.

Medical records were reviewed regarding clinical indications for MRI/CT studies and imaging results. Indications used for MRI/CT scanning were defined and compared to those recommended by the current clinical practice guidelines for the management of chronic headache in children¹¹.

Clinical indications for performing neuroimaging studies, according to established guidelines, were

clustered in two groups: 1) abnormal neurological examination (focal deficit, clear signs of increased intracranial pressure, alteration of consciousness); and 2) associated features that suggest neurological dysfunction (morning vomiting, nausea, dizziness, "worst headache"). Moreover, we added anxiety and/or insistence of children's families and age under 5 years in neurologically intact children as separate indications for neuroimaging studies.

Neuroimaging results were presented as "normal", "incidental" or "abnormal". Abnormal neuroimaging findings were defined as pathologic neuroanatomic findings that resulted in significant change in the child's clinical management. Incidental findings were any remarks, observations revealed by neuroradiologist of unexpected, "incidental" detection that was believed to be unrelated to the child presenting headache symptoms and did not require any significant change in the child's headache management. Incidental findings were divided into intracerebral or extracerebral. For data interpretation we used frequencies (real numbers and percentage).

Results

Patient characteristics

Two-hundred and fifteen patients were admitted to the hospital due to chronic headache. The subjects' age ranged from 2 to 18 years, mean age 11 years, median 12; there were 100 (46.5%) male children, mean age 9.7 years and 115 (53.5%) female children, mean age 11.8 years.

The majority of patients, 168/215 (78.1%), had general physical and neurological examination, as well as past medical history unremarkable. There were 4/215 (1.9%) children with abnormal neurological examination; 22/215 (10.2%) children with the presence of associated features suggesting neurological dysfunction, and 21/215 (9.8%) children aged under 5 years (Table 1).

In four patients with altered neurological status, the following abnormalities were described: diplopia, motor and gait dysfunction, alteration of consciousness, speech impediment, horizontal nystagmus, asymmetry of deep tendon reflexes, and unilateral hand tremor.

Associated features suggesting neurological dysfunction included nonspecific vision disturbances such as blurred vision, impaired visual acuity, un-

Table 1. Indications for neuroimaging procedures and neuroimaging findings in children with chronic daily headache

	Neuroimaging indications								Total	
	Family insistence		Abnormal neurologic examination		Possible neurologic dysfunction		Age <5 years			
Neuroimaging results	n	%	n	%	n	%	n	%	N	%
Normal findings	85	51.8	2	1.2	11	6.7	19	11.6	117	71.3
Incidental findings	32	19.5	1	0.6	11	6.7	2	1.2	46	28.1
Abnormal findings	0	0.0	1	0.6	0	0.0	0	0.0	1	0.6
Total	117	71.3	4	2.4	22	13.4	21	12.8	164	100.0

specific optic fundus examination in 13/215 (6.0%) children, nausea and/or vomiting and/or dizziness in 7/215 (3.3%) children, and unilateral facial numbness in 2/215 (0.9%) children.

Neuroimaging results

Brain imaging was performed in 164/215 (76.3%) children. MRI was performed in 93 (56.7%) and CT in 71 (43.3%) children. Indications for neuroimaging studies as well as neuroimaging results are presented in Table 1.

In the great majority of children, 117/164 (71.3%), neuroimaging studies were performed upon insistence and/or due to concern of their families because of the associated features suggesting neurological dysfunction (13.4%), age under 5 years (12.8%) and abnormal neurological examination (2.4%). Most of the children (117/164; 71.3%) had normal neuroimaging findings. In 46/164 (28.1%) children, MRI/CT results were incidental, i.e. different intracerebral/extracerebral findings revealed asymmetry of the ventricular system, enlargement of cisterna magna and retrocerebellar cistern, foci of gliosis, pineal and/or subarachnoid cyst, calcification of falx cerebri, cortical atrophy, white matter hyperintensities, sinusitis, adenoid enlargement and fluid retention in mastoid cells, which did not influence changes in headache management.

Only one child (1/164=0.6%) in which MRI revealed brain tumor required change in headache management after brain imaging. This child demonstrated abnormal neurological examination on the day of presentation (balance disturbances, motor asymmetry and asymmetry of deep tendon reflexes).

Discussion

Routine clinical practice of neuropaediatricians clearly shows that neuroimaging studies have a limited value in children with chronic headache. These observations have been comprehensively investigated and discussed during the past decades¹⁸⁻¹⁹. Consequently, recommendations for the use of neuroimaging have been established in clinical practice guidelines on the basis of the principles of evidence-based medicine¹¹. According to these, obtaining a neuroimaging study on a routine basis is not indicated in children with recurrent headaches and normal neurological examination.

The practice guidelines do not differentiate children with recurrent headache younger than 5 years as a specific group of patients, nor are the recommendations altered by the child's age. Headache in young children may not always meet the usual diagnostic criteria and a higher percentage of children aged 2 to 5 years have a life-threatening cause of headache when compared with older children¹².

Moreover, 'dangerous' headache caused by brain tumors may be more common in this population and requires prompt specific management. Therefore, diagnostic approach to this group of children is of great importance and requires specific reflections, thus neuroimaging should also be justifiably considered in these patients.

Our Department routine in children with headache is to obtain detailed history, perform complete systemic physical examination including arterial blood pressure measurement, detailed neurological examination, complete ophthalmologic examination,

ear-nose-throat specialist examination as well as psychological evaluation. Electroencephalogram was also usually performed.

Our routine is to perform neuroimaging studies after a clinical follow up of maximum one month in children younger than 5 years with normal neurological examination and no associated features indicative of neurological dysfunction.

Using this approach in this series of children we treated 21 (12.8%) children with headache younger than 5 years with normal neurological examination and no associated features suggesting neurological dysfunction. All children had normal MRI/CT findings (19 children had normal and two incidental findings), i.e. we did not detect any pathology that would require significant change in headache management. Therefore, our results suggest that the routine use of MRI/CT is not warranted in preschool children with normal neurological examination, with no associated features indicative of neurological dysfunction and with clearly defined headache type. Even these results confirm conclusions of similar studies that only prospective study in this specific age group of children would give a definite answer regarding neuroimaging use in young children with headache.

We performed MRI/CT in 76.3% of children, meaning that in daily clinical practice neuroimaging studies are not only performed to exclude intracranial pathology. CT scan was mostly performed because parents insisted on it, even though they knew that it was not healthy for their children. Our data are consistent with other reports where the rates of neuroimaging studies in children with chronic headache ranged from 35% to 81%^{16,18}.

In the present study, true indications for obtaining neuroimaging studies, such as the presence of neurological abnormalities and atypical headache pattern suggesting neurological dysfunction, were established in four (2.4%) and 22 (13.4%) children, respectively (26 children; 15.8%). In the remaining patients (71.3%), excluding those younger than 5 years, brain MRI/CT was obtained due to the parents' concern about a serious underlying brain disease, mostly brain tumor.

The incidence of brain tumors is low, 3-5 *per* 100,000. Moreover, only 1 of 10 children present with headache as the only symptom. In our series of 82 children with primary brain tumors, the most prominent symptoms

were vomiting or vomiting with headache, and all children had abnormal neurological examination^{20,21}. Morris *et al.* in their meta-analysis regarding incidental findings on brain MRI have shown that 0.7% of people (135 of 19 599) were found to have incidental neoplastic brain findings²². In our study, only one of 164 children imaged for headache was found to have brain tumor, yielding 0.6%, a rate that is even lower than the rate in healthy people. Moreover, none of the children with normal neurological examination had neuroimaging studies that required change in headache management. The child with the brain tumor presented to the Department with evident and recognizable neurological signs of posterior intracranial pathology. It is very rare that a child has brain tumor that is unpredictable by thorough clinical assessment and ophthalmologic examination. It is important to mention that delay in the diagnosis of brain tumor in children does not decrease the probability of survival²³.

Our results showed that 28.1% of children had some sort of intracerebral or extracerebral findings on neuroimaging studies. Most of these findings were incidental and required neither significant nor any change in headache management at all. Intracerebral findings were generally physiological variations of brain anatomical structures. When using modern sequences, incidental findings of intracerebral alterations were relatively high^{24,25}. Depending on the criteria for incidental findings and studied populations, their incidence ranged from 20% to 50%^{26,27}. However, in a very low percentage of children (0.3% to 3.8%), the incidental findings described were relevant to headache²⁴⁻²⁸.

The most common extracerebral findings in our series were sinusitis, adenoid enlargement and fluid retention in mastoid cells. Sinus disease has been previously reported in 1% to 13% of patients imaged for headache²⁴⁻²⁶. Whether these findings had a significant clinical implication on headache remains to be found out. Our practice is to refer patient to otolaryngologist when neuroimaging studies show any alteration in sinuses, mastoid cells or nose. By experience, in extremely rare cases, these children received antibiotic or other specific therapy.

By our practice, incidental neuroimaging findings in children with chronic headache, whether intra- or extracerebral, usually increase the parental/family

fear and anxiety rather than providing them with reconciliation. Furthermore, all extensive blood tests, cerebrospinal fluid tests, repeated neuroimaging studies in children without clinical and history specific diseases but with incidental MRI/CT findings revealed no specific pathology²⁶⁻²⁸.

Each neuropediatrician can find valid and reasonable reasons to disrespect practice guidelines after weighing estimated benefits against the potential risks, harms and costs in individual child's surroundings. In practice, pediatricians usually take into account their personal experience and expertise with evidence-based guidelines in decision-making on behalf of their particular patients.

In this study, neuroimaging was performed in 71.3% of children without any indications proposed by the valid clinical guidelines. If we add the children younger than 5 years, that will make 138/164 or 84% of children who were exposed to unnecessary diagnostic procedures. This defensive medicine was also noted in other studies¹⁶⁻¹⁸. Yilmaz *et al.* report on a series of 449 children with headache where neuroimaging studies were performed in 72.2% of children and the indication for MRI were parental anxiety about brain tumors in 81.8% of patients¹⁶.

Plausible reasons for overuse of pediatric neuroimaging procedures may be pediatrician's judgment/behavior such as time constraints in primary care practice, pediatrician's anxiety (fear of liability), unreliable history/examination, indoctrination of imaging technology use, misunderstanding of appropriateness of the guidelines, false belief in the need of documentation, delayed availability of neurology consultation, and financial/reimbursement incentives¹⁴. On the other hand, even parental expectations or demands must be taken into account, i.e. parental anxiety as fear from brain tumor, exaggeration of pain severity, parental reassurance (i.e. anxiolytic use of technology), mistrust in physician reassurance, direct-to-consumer marketing of imaging centers, or medicalization of the childhood stress phenomena¹⁴.

This study was performed at a single institution, regional children's hospital that serves a large urban, suburban and rural area. Two pediatric neurologists worked at the Department during the study period. The Department is the main center for pediatric neurology, and there were no pediatric neurologists in practice in

the area. The great majority of children presented with headache, therefore were seen by a neuropediatrician, and these results represent the institution experience. A limitation of this study is retrospective design and lack of prospective clinical follow up data after neuroimaging study was performed. Possibly, in that manner, we may be able to prove that in some cases neuroimaging studies serve not only as a diagnostic method, but also as a therapeutic procedure.

Even so, this study proved that, despite available evidence-based clinical guidelines, brain imaging in children with chronic headaches is overused, mostly in order to decrease the family/patient concerns. It is of utmost importance that the parents who insist on neuroimaging procedure be aware of the possibility of a high chance of discovering incidental findings, which does not and will not negatively influence their child's health. Physicians should devote more time to explaining the nature of the headache to patients and families, thus reducing their anxiety.

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Sažetak

NEUROSLIKOVNE PRETRAGE U DJECE S KRONIČNOM GLAVOBOLJOM U KLINIČKOJ PRAKSI

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Cilj rada bio je utvrditi postoji li značajan nesrazmjer između kliničke prakse i kliničkih smjernica u svezi indikacija za provođenje neuroslikovnih pretraga u djece s kroničnom glavoboljom. Analizirana je medicinska dokumentacija djece s kroničnom glavoboljom u dobi od 2 do 18 godina liječene u Kliničkom bolničkom centru Rijeka, Klinika za pedijatriju "Kantrida". Indikacije za provođenje magnetske rezonancije i kompjutorizirane tomografije (MR/CT) mozga uspoređene su s indikacijama preporučenim u smjernicama. MR je učinjen u 93 (56,7%) djece, a CT u 71 (43,3%) djeteta, ukupno u 164 (76,3%) od 215 djece. Indikacije za MR/CT mozga bile su: tjeskoba i/ili inzistiranje obitelji (71,3%), prisutnost pridruženih simptoma koji su ukazivali na neurološki poremećaj (13,4%), djeca mlađa od 5 godina (12,8%) i promijenjen neurološki status (2,4%). U većine djece (71,4%) nalaz MR/CT bio je uredan. U ostalim MR/CT nalazima opisane su intra-/ekstracerebralne promjene koje nisu utjecale na promjene u terapijskom pristupu (28,1%). U samo jednog djeteta (0,60%) promijenjen je terapijski pristup nakon provedene neuroslikovne pretrage. Ovo ispitivanje dokazuje da se, unatoč dostupnim kliničkim smjernicama, neuroslikovne pretrage mozga u djece s kroničnim glavoboljama prekomjerno provode, uglavnom s ciljem umanjivanja tjeskobe roditelja i/ili zbog njihovog inzistiranja da se iste učine.

Ključne riječi: Djeca; Glavobolja; Neuroslikovne pretrage; Praktične smjernice