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Practice parameter: Evaluation of children and adolescents with recurrent headaches

Report of the Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society

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Abstract—*Objective:* The Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society develop practice parameters as strategies for patient management based on analysis of evidence. For this parameter, the authors reviewed available evidence on the evaluation of the child with recurrent headaches and made recommendations based on this evidence. *Methods:* Relevant literature was reviewed, abstracted, and classified. Recommendations were based on a four-tiered scheme of evidence classification. *Results:* There is inadequate documentation in the literature to support any recommendation as to the appropriateness of routine laboratory studies or performance of lumbar puncture. EEG is not recommended in the routine evaluation, as it is unlikely to define or determine an etiology or distinguish migraine from other types of headaches. In those children undergoing evaluation for recurrent headache found to have a paroxysmal EEG, the risk for future seizures is negligible; therefore, further investigation for epilepsy or treatments aimed at preventing future seizures is not indicated. Obtaining a neuroimaging study on a routine basis is not indicated in children with recurrent headaches and a normal neurologic examination. Neuroimaging should be considered in children with an abnormal neurologic examination or other physical findings that suggest CNS disease. Variables that predicted the presence of a space-occupying lesion included 1) headache of less than 1-month duration; 2) absence of family history of migraine; 3) abnormal neurologic findings on examination; 4) gait abnormalities; and 5) occurrence of seizures. *Conclusions:* Recurrent headaches occur commonly in children and are diagnosed on a clinical basis rather than by any testing. The routine use of any diagnostic studies is not indicated when the clinical history has no associated risk factors and the child's examination is normal.

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Headaches are common in children and become increasingly more frequent during adolescence. In 1962, Bille[1] published his landmark epidemiologic survey of headache among 9,000 school children documenting that more than one third of 7-year-old children and half of 15-year-old children reported having had at least one headache. Data from 5 retrospective studies published between 1977 and 1991 of 27,606 children found the prevalence of any type of headache to range from 37 to 51% in 7 year olds, gradually increasing to 57 to 82% by age 15 years.[2-6] Prepubertal boys were also found to be more affected with headache than girls, whereas after puberty, headaches were found more commonly in females.

QSS Educational Statement: The Quality Standards Subcommittee (QSS) of the American Academy of Neurology seeks to develop scientifically sound, clinically relevant practice parameters for neurologists for diagnostic procedures, treatment modalities, and clinical disorders. Practice parameters are strategies for patient management that might include diagnosis, symptom, treatment or procedure evaluation. They consist of one or more specific recommendations based on analysis of evidence.

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The prevalence of migraine headache in children has also been studied extensively.[7-12] Based on data from six retrospective case series between 1962 and 1994 of 13,130 children and adolescents, prevalence data for migraine headache by age groups were: 3 to 7 years old—1.2 to 3.2% (male [M] > female [F]); 7 to 11 years old—4 to 11% (M = F); and 11 to ≥15 years old: 8 to 23% (F > M).[7-12]

The evaluation of a child with headache begins with a thorough medical history followed by methodical physical examination with measurement of vital signs, particularly blood pressure, and a complete neurologic examination including examination of the optic fundus. Diagnosis of primary headache disorders of children rests principally on clinical criteria as set forth by the International Headache Society.[13] Clues to the presence and identification of secondary causes of headache are uncovered through this systematic process of history and physical examination. The principle indication for performance of ancillary diagnostic testing rests on information or concerns revealed during this fundamental process.

There is a lack of consensus concerning the role of diagnostic testing including routine laboratory testing, CSF examination, EEG, and neuroimaging with CT or MRI. This is due in large part to the lack of well-designed prospective studies involving sufficient numbers of patients with specifically defined types of headaches that could address these issues. Such information would be extremely valuable for patients, their families, and their physicians in developing effective evaluation strategies.

Before reviewing the evidence and recommendations related to diagnostic testing in children with recurrent headaches, it is important to consider that a child may present acutely with a severe headache that may require the physician to consider urgent or emergent testing to determine whether an underlying systemic disease process is present. For example, if subarachnoid hemorrhage, acute or chronic meningitis, idiopathic intracranial hypertension, or certain other conditions are suspected, lumbar puncture with opening pressure measurement and appropriate ancillary testing are indicated. The presence of headache accompanied by fever or in the immunocompromised patient must raise concerns for infections such as meningitis, either bacterial or viral. If the clinical examination demonstrates nuchal rigidity with or without alteration of consciousness, signs of increased intracranial pressure, mental status changes, or lateralizing features, neuroimaging followed by lumbar puncture may need to be performed.[14]

This practice parameter reviews available evidence concerning the value of diagnostic testing in children and adolescents who report recurrent headache and provides recommendations based on this evidence. Headache types reviewed in this parameter include migraine, tension-type, and other primary headache disorders, as well as headaches that are secondary to other conditions or syndromes as outlined by the International Headache Society.[13] It pertains to children, 3 to 18 years old, who present for the evaluation of recurrent headache unassociated with trauma, fever, or other obvious provocative causes.

Methods. Computer-assisted literature searches were conducted with the assistance of the University of Minnesota Biomedical Information Services Research Librarian for relevant articles published from 1980 to 2000. Databases searched included MEDLINE and CURRENT CONTENTS using the following "key words": headache, migraine, tension-type headache, electroencephalography, computed tomography, magnetic resonance imaging, blood chemical analysis, neurological examination, diagnostic errors. In addition, the database provided by CURRENT CONTENTS was searched for the most recent 6-month period. Five selected articles published before 1980 that were found in bibliographies of recent publications also were included as they contained important epidemiologic data from large case series of children.[2,7,10-12] The age qualifier of 3 to 18 years was selected, as this is the age group, based on previous literature, when most children are seen for pediatric or neurologic evaluation. Searches included titles from English and non-English language journals. Only those articles reporting studies with more than 25 patients were included. Articles consisting of single patient case reports or small samples of unusual pathologic findings, which would have biased the analysis, were excluded. Only studies that contained information about the patients' neurologic examinations were included. A bibliography of the 398 articles identified and reviewed for preparation of this parameter is available at the American Academy of Neurology (AAN) Web site (http://www.aan.com). Relevant position papers from professional organizations also were reviewed.

Individual committee members reviewed titles and abstracts for content and relevance. Those articles dealing with investigations of headache with reference to determining a possible etiology were selected for further detailed review. Bibliographies of the articles cited were checked for additional pertinent references. Each of the selected articles was reviewed, abstracted, and classified by at least two committee members. Abstracted data included the number of patients, age, sex, nature of subject selection, case-finding methods (prospective, retrospective, or referral), inclusion and exclusion criteria, headache type and characteristics, neurologic examination, and the results of laboratory, EEG, or neuroimaging tests.

A four-tiered classification scheme for diagnostic evidence recently approved by the Quality Standards Subcommittee was used as part of this assessment (table 1). Depending on the strength of this evidence, it was decided whether specific recommendations could be made, and if so, the strength of these recommendations (table 2). Evidence pertinent to each di-

Table 1 *AAN evidence classification scheme for a diagnostic article*

Class	Level of evidence
I	Evidence provided by a prospective study of a broad spectrum of persons who may be at risk for developing the outcome (e.g., target disease, work status). The study measures the predictive ability using an independent gold standard for case definition. The predictor is measured in an evaluation that is masked to clinical presentation and the outcome is measured in an evaluation that is masked to the presence of the predictor.
II	Evidence provided by a prospective study of a narrow spectrum of persons who may be at risk for developing the outcome, or by a retrospective study of a broad spectrum of persons with the outcome compared with a broad spectrum of control subjects. The study measures the predictive ability using an acceptable independent gold standard for case definition. The risk factor is measured in an evaluation that is masked to the outcome.
III	Evidence provided by a retrospective study where either the persons with the condition or the control subjects are of a narrow spectrum. The study measures the predictive ability using an acceptable independent gold standard for case definition. The risk factor is measured in an evaluation that is masked to the outcome.
IV	Any design where the predictor is not applied in a masked evaluation OR evidence provided by expert opinion or case series without control subjects.

agnostic test together with the committee's evidenced-based recommendations is presented.

Laboratory studies and lumbar puncture. *Should laboratory studies including lumbar puncture be performed in children with recurrent headache? Evidence.* A review of the literature disclosed only one class III study of 104 children who were being evaluated by a pediatric neurologist in whom laboratory studies including complete blood count, electrolyte levels, liver function profiles, and urinalysis were performed by the referring pediatrician.[15] The laboratory studies were described as "uniformly unrevealing" but the number of patients studied and specific laboratory data were not described. No other reports investigating the role of laboratory studies in the evaluation of recurrent headache in children or adolescents have been published. One class II prospective study of 193 adults with migraine headache who had laboratory testing (complete blood count, sedimentation rate, serology, urinalysis, and chest x-ray) did not find any clinically relevant diagnostic information.[16]

Literature review disclosed no studies concerning the role of routine lumbar puncture in the evaluation of headache in children and adolescents. The AAN has published a parameter on diagnostic and therapeutic indications for performing lumbar puncture in adults and children, which did not include recurrent headache as an indication.[17]

Recommendations There is inadequate documentation in the literature to support any recommendation as to the value of routine laboratory studies or performance of routine lumbar puncture in the evaluation of recurrent headache in children (Level U; class IV evidence).

EEG. *Should an EEG be performed in children with recurrent headaches?* The role of EEG and the controversies surrounding its attendant use in the evaluation of recurrent headaches in children has been the subject of several reviews.[18-20] In spite of recommendations not to include the EEG as part of the routine evaluation of children with recurrent headache, it is not uncommon in clinical practice for an EEG to be obtained. A previously published practice parameter by the AAN addressed this issue in adults and came to the conclusion that an EEG was not useful in the routine evaluation of a patient with recurrent headaches.[21] The parameter did not exclude the use of EEG to evaluate patients with recurrent headache who had associated symptoms suggesting a seizure disorder.

Data from published studies on the use of the EEG in the evaluation of recurrent headaches, particularly in children, are difficult to interpret.[18] Methodologic problems range from the patient population having mixed types of headaches, ill-defined headache diagnostic criteria, multiple age groups, lack of comparisons of the study population to age-matched control subjects, unclear definitions of EEG abnormalities, and the fact that certain EEG abnormalities previously considered abnormal in children are currently not considered pathologic.

Table 2 *AAN system for translation of evidence to recommendations*

Translation of evidence to recommendations	Rating of recommendation
Level A rating requires at least one convincing class I study or at least two consistent, convincing class II studies	A = Established as useful/predictive or not useful/predictive for the given condition in the specified population
Level B rating requires at least one convincing class II study or overwhelming class III evidence	B = Probably useful/predictive or not useful/predictive for the given condition in the specified population
Level C rating requires at least two convincing class III studies	C = Possibly useful/predictive or not useful/predictive for the given condition in the specified population
	U = Data inadequate or conflicting. Given current knowledge, test, predictor is unproven.

Table 3 *Results of EEG testing in children with headaches*

HA type	n	Class	Age, y	M:F ratio	EEG		Slowing (%)	Spike and sharp (%)	Other abnormal (%)	Reference
					Normal (%)	Abnormal (%)				
All	257	3	3–16	1.2:1	79.4	20.6	8.6	12.1	0	23
All	211	3	3–16	1.4:1	75.4	24.6	0	22.7	1.9	15
All	49	3	1.5–18	1.1:1	59.2	40.8	14.3	10.2	16.3	24
All	412	3	2–17	1:1	86.7	13.3	4.4	7.3	1.7	22
Migraine	28	2	7–15	0.56:1	25	75	25	10.7	50	25
Migraine	100	2	3–15	NA	89	11	1	10	0	26
Migraine	27	3	4–15	NA	48.1	51.9	0	33.3	44.4	27
Migraine	64	3	NA	NA	26.4	73.4	27	46.9	12.5	28

Evidence. Eight studies have assessed EEG use in 1,148 children with recurrent headaches (table 3).[15,22-28] Five studies were published since 1980. One class II and one class III study from 1967 also were included because they contained data that compared children with recurrent headaches to control subjects[25] and family members and control subjects,[27] data that were not available from more recent studies. A 1960 study of 500 children with recurrent headache reported that 44% of EEGs were abnormal.[29] Of these 220 children, 22% had spike discharges, 38% had paroxysmal slow wave activity, 37% had generalized slowing, and 3% had fast activity. Of the eight studies, four reported data on children with "all" types of headaches; headaches in this group included tension headaches, migraine, "sinus" headache, and so on. The remaining four studies focused on children with migraine.

Brief review of these eight studies. *All headache group.* In the four available studies (all class III),[22-26] children with all types of headaches were included (see table 3). Headaches in these 929 children were categorized as migraine (44%), tension/traction (30%), involvement of head/neck structures (3%), seizure-related (7%), psychogenic (1%), and other etiologies/unclassified (e.g., disorders of ocular motility) in the individual studies (15%). Data for the headache subgroups were pooled so that extraction of information on the patients with migraine vs all other groups could not be done. The high incidence of headaches thought to be seizure-related was based on data from a single study in which 58 of 211 patients were diagnosed with seizures.[15] Only one other study diagnosed headaches that were considered seizure-related in 6 of 92 children.[24] Three of these six patients were either unconscious or had vertigo with their headache. In neither of the remaining two studies (n = 669) was seizure-related headaches diagnosed.[22,23]

Migraine group. Of the four studies involving 219 children with migraine,[25-28] 2 were class II, and 2 were class III (see table 3). Varying diagnostic criteria for migraine were used and none of the studies used the currently accepted International Headache Society (IHS) criteria. In 1 class II study, EEG data on 28 children with well characterized migraine headaches and normal neurologic examinations were compared with an age-matched control group.[25] Although the percentage of patients with an abnormal EEG was greater in the migraine (75%) compared with the control group (50%), this was because of a higher incidence of a specific EEG pattern (14 and 6 cycles per second) in the migraine group (46.4%) compared with control subjects (17.9%). This pattern is now considered a benign variant. Other EEG abnormalities were similar in the migraine (29%) and control (32%) groups.

A class II and class III study involving 127 children with well-defined migraine headaches and otherwise normal neurologic function found the EEG to be abnormal in 11%[26] and 52%[27] of patients. In the study in which 11% of EEGs were abnormal, 9% had benign focal epileptiform discharges that was a higher incidence than that reported in a healthy population (1.9%; $p < 0.001$).[26] This EEG abnormality is associated with benign focal epilepsy of childhood but has been reported in other studies in which 15 to 32% of children did not have seizures.[26] The class III study compared EEG in 27 children with migraine headaches, 32 siblings, 45 parents, and 21 control children.[27] Typical migraine (siblings, 41%; parents, 46%) and nonmigraine (siblings, 17%; parents, 13%) headaches were recorded from family histories. Paroxysmal abnormalities were noted in patients (33%) and to a lesser extent in siblings (12%), but not in parents or control subjects. Other EEG abnormalities occurred in 48% of patients, 25% of siblings, 9% of parents, and 4% of control subjects.

The fourth study was a class III retrospective study of 84 children for whom 64 patients nonselectively had an EEG with the following results: normal (27%), diffuse slowing (38%), paroxysmal activity (27%), and focal abnormalities (13%).[28] Of the 17 patients with paroxysmal EEG, 7 had a history of seizures, 10 had no history of seizures, and 4 of these 17 had a family history of seizures.

Table 4 *EEG abnormalities*

A. EEG abnormalities in children with migraine vs "all" headaches*

EEG pattern	Migraine headache, n = 219, % EEG findings	"All" headache, n = 929, % EEG abnormality	*p* Value
Normal	47 ± 30	75 ± 12	0.33
Abnormal†	53 ± 30	25 ± 12	0.33
Diffuse slowing	11 ± 12	7 ± 1	0.42
Spike activity	25 ± 18	13 ± 1	0.42
Other abnormalities	27 ± 24	5 ± 1	0.55

B. Percentage of patients who had or developed seizures in children with recurrent headaches‡

Group	Patients with EEG findings, %	Patients with past seizures, %	Patients who develop seizures, %
"All" headaches			
Normal EEG	25	0	0
Nonparoxysmal	12	0	0
Paroxysmal	13	18	0
Migraine headaches			
Normal EEG	53	2	0
Nonparoxysmal	22	5	0
Paroxysmal	25	13	0

* Data analysis was based on eight studies listed in Table 3. In section A, the migraine group was compared with the "all" headache group using a χ^2 analysis (Pearson coefficient) with p significant at <0.05 [SPSS Statistics for Windows (SPSS Inc., Release 6.0, Chicago, IL)].

† Some patients had more than one type of abnormality.

‡ Data analysis was based on eight studies listed in Table 3.

We examined the data with regard to the following questions:

1. Should an EEG be done routinely in the evaluation of a child with recurrent headaches? Data from the eight studies (table 4, section A) show that the EEG was not necessary for distinguishing a diagnosis of primary headache disorder in children (migraine, tension-type headache) from secondary headache caused by structural disease involving the head and neck or those caused by a psychogenic etiology.

Conclusions. Data from four studies of children with all headaches and four studies of children with migraine demonstrate that the EEG is either normal or demonstrates nonspecific abnormalities in most patients. Furthermore, in those patients in whom the EEG was abnormal, there was no indication that this finding provided any diagnostic information concerning the etiology of headache, or specifically that the headache was due to a seizure for the majority of recurrent headache types in children.

2. Is the EEG useful in differentiating migraine from other types of headaches? Previous studies in children (as well as in adults) have suggested that the EEG in patients with migraine is more likely to be abnormal (particularly paroxysmal abnormalities) than in patients with other types of headaches.[20] This has led to using the EEG to diagnose migraine based on the assumption that this would lead to migraine-specific treatments. This issue is further complicated in childhood because the incidence of paroxysmal abnormalities detected by EEG in healthy children is greater than in adults.[18]

Table 4 (section A), based on pooled data from 219 children with migraine and 929 with all headaches, shows that there was no significant difference in EEG abnormalities (slowing, spike activity, other abnormalities) in children with migraine compared with the all headache group. The lack of difference is likely due, in part, to the fact that 44% of patients in the all headache group were diagnosed with migraine. As previously noted, extraction of information on the patients with migraine compared with other groups could not be done in these studies. Even if some differences were found between these two groups (i.e., migraine vs nonmigraine), there was no evidence that the EEG findings would be of sufficient specificity or sensitivity in an individual patient to be clinically useful. The diagnosis of migraine and other primary headache disorders is made primarily on clinical grounds based on information gleaned from the history of the patient's symptoms and lack of findings on examination.

Conclusions. There are no studies that clearly compare the incidence of EEG abnormalities in migraine vs nonmigraine pediatric headache patients. Overall, the data do not suggest that there are differences in the EEG between children with migraine compared with other recurrent headache types that would be diagnostically useful in the individual patient to determine an etiology or to make a diagnosis of migraine.

3. Does the EEG determine that the cause of recurrent headaches is seizures? Seizure-related headaches have been recognized in the past[30,31] but they remain infrequently diagnosed and controversy remains as to whether such an entity even exists.[18] Data are only available from a single class III study that addresses this issue.[15] In this study of 215 children, "seizure headaches" were diagnosed in 58 children (27%). A seizure headache was described as a "paroxysmal brief headache" accompanied by nausea, vomiting, or other autonomic signs followed by postictal lethargy or sleep with "typical epileptiform discharge" on EEG recording. The authors do not define the "typical EEG" features but describe 36 patients with partial, 3 with generalized, and 5 with multifocal seizures. The authors do not state when the EEG was performed in relation to the epoch of headache. These patients had a much higher incidence of abnormal EEG that were paroxysmal (75.9%; n = 44) compared with other groups (migraine: 8.3%; psychogenic: <1%; remaining groups

did not show paroxysmal abnormalities). Eleven of 58 children had a previous history of seizures.

Conclusions. Data from one class III study suggest the concept that children may have seizure-related headaches and that in these children the EEG is likely to be paroxysmal. The limited available literature suggests that this condition is infrequently diagnosed and its existence as a clinical entity is still questioned.

4. Does the EEG indicate that the child with recurrent headaches will develop seizures? Children with migraine were equally likely to have had a history of seizures as the all headache group (see table 4, section B). A history of previous seizures was more frequent in the children who had a paroxysmal EEG compared with children with a normal or a nonparoxysmal EEG. None of the patients in these eight studies was reported to have developed seizures after being followed for headaches regardless of whether the EEG was paroxysmal. Data from the individual studies did report that some of the patients, depending on the type of seizure disorder they had (i.e., partial complex seizures) were likely to have continued recurrent seizures unrelated to their headaches. The duration of follow-up in most studies was inconsistent so that it is uncertain whether some children with recurrent headaches and a paroxysmal EEG would develop seizures beyond 1 year after their evaluation.

Conclusions. Data from 8 studies did not report any patients who subsequently went on to develop new-onset seizures after clinical evaluation for headaches even when the EEG showed paroxysmal abnormalities

Recommendations

1. EEG is not recommended in the routine evaluation of a child with recurrent headaches, as it is unlikely to provide an etiology, improve diagnostic yield, or distinguish migraine from other types of headaches (Level C; class II and class III evidence).
2. Although the risk for future seizures is negligible in children with recurrent headache and paroxysmal EEG, future investigations for epilepsy should be determined by clinical follow up (Level C; class II and class III evidence).

Neuroimaging. In 1994, the AAN published a practice parameter on neuroimaging use in the evaluation of headache in adults with normal neurologic examinations.[32] Based on review of the literature of CT and MRI scans in 897 adults, they recommended that routine neuroimaging was unwarranted in patients with recurrent migraine headaches with no recent change in pattern, history of seizures, and no other focal neurologic signs or symptoms. If any of these features were present, such studies might be indicated. This issue was readdressed in a subsequent AAN parameter in 2000[33] and in a report of the US Headache Consortium[34] with similar recommendations. Data are available from six pediatric studies to consider whether these recommendations are applicable to children with recurrent headaches.

Should CT or MRI be performed in children with recurrent headaches? Evidence. Six studies (1 class II and 5 class III) in which 605 of 1,275 children with recurrent headaches who underwent neuroimaging were reviewed (table 5).[35-40] All assessed neuroimaging use in children with recurrent headache and one reported EEG data. The patients were collected from different populations, five studies used clinic-based populations and one used only children referred for neuroimaging.[36] Only one specifically focused on clinical subsets (e.g., migraine and chronic daily headache); the rest were from mixed populations of headache subtypes. For the entire group of children, the types of headaches included migraine (62%), tension (22%), mixed type (2%), post-traumatic (2%), seizure-related (1%), tumor (1%), psychogenic (<1%), other (8%), and unclassified (3%).

CT scans were performed in 116, MRI in 483, and both modalities in 75 patients. Those not imaged were followed clinically and no long-term problems were found for the 1- to 2-year follow-up time period reported in several of these studies. Imaging abnormalities were found in 97 children (16%) (see table 5). In 79 of these children, the abnormalities were considered to be incidental, a nonsurgical lesion or one that did not require specific medical management. Nonsurgical abnormalities included: Chiari malformation (n = 24), arachnoid cyst without mass effect (n = 13), paranasal sinus disease (n = 13), occult vascular malformations (n = 5), pineal cyst (n = 2) plus a variety of incidental structural abnormalities in 22 (i.e., cavum septi, pineal cysts, ventricular asymmetry, and "hyperintense" lesions). Eighteen children (3.0%) had a surgically treatable lesion (n = 14) or a lesion (n = 4) that required medical treatment (e.g., pituitary adenoma that resolved spontaneously). Ten children had tumors (two medulloblastomas; two cerebellar astrocytomas; one each of choroid plexus papilloma, sarcoma, primitive neuroectodermal tumor, glioblastoma multiforme, brain stem glioma, and craniopharyngioma). Symptomatic vascular malformations were found in three children and an arachnoid cyst that necessitated surgery was found in one patient. Critically, in all 14 children with CT or MRI lesions considered surgically treatable, abnormalities were described on neurologic examination and included papilledema, abnormal eye movements including nystagmus, and motor or gait dysfunction. In one class III study that accounted for most of the surgical cases, the authors also performed univariate analysis on the 28 children who had surgical and nonsurgical space-occupying lesions. In this study, all patients were examined by a neurologist and five predictive variables were determined that helped distinguish patients with space-occupying lesion from those without such lesions.[36] Variables that predicted the

Table 5 *Results of neuroimaging testing in children with headaches*

HA type	n	Class	Age, y	M:F ratio	CT/MRI, n	Findings	Patients in whom neuroimaging affected management, n	Reference
Mixed	133	3	3–18	1.2:1	27/45	11 abnormal, 7 sinus disease, 4 cerebral abnormalities*	0/78	35
Mixed	315	3	3–20	1:1	69/315	53 abnormal, 13 had surgical lesions	17/315	36
Mixed	157	3	NA	NA	7/0	5 normal, 1 dilated L vent, 1 choroid plexus papilloma†	1/7	37
Mixed	429	2	5–18	0.85:1	0/96	79/96 normal, 17 abnormal‡	0/96	38
Mixed	104	3	0.2–6.9	1.1:1	23/7	25 normal, 5 abnormal§	0/30	39
Mixed	137	3	6–18	NA	59/20	3.7% of patients with migraine and 16.6% of chronic daily headache patients had abnormal scans	0/79	40

* One neuroepithelial cyst, one cerebral hemiatrophy, one Dandy Walker malformation, one arachnoid cyst.
† One choroid plexus papilloma, 2.5 year old with headache associated with downward eye deviation.
‡ Two lacunar lesions, one hyperdense lesion, one venous angioma, one elongated basilar artery, one arachnoid cyst, four with cavum septi pellucidum, one cavum vergae, two pineal cysts, one gyral change, two sulcal enlargement, five lateral ventricle asymmetry.
§ One old infarct secondary to remote meningitis, one CT changes following remote tuberculous meningitis, one old subdural hematoma (post-traumatic), one congenital hydrocephalus, VP shunt, dysmorphic brain, one Chiari malformation.

presence of a space-occupying lesion included: 1) headache of less than 1 month duration; 2) absence of a family history of migraine; 3) abnormal neurologic findings on examination; 4) gait abnormalities; and 5) occurrence of seizures. In one class III study, 79 of 137 children examined by a child neurologist were scanned, and in those with normal neurologic examinations, no surgically remediable lesions were found.[40]

One recent class II report analyzed the cost-effectiveness of a diagnostic imaging strategy in children with headache who were suspected of having a brain tumor. Patients were stratified into low, intermediate, and high-risk groups based on clinical predictors obtained from medical history and physical examinations. The probability of brain tumor in the three groups was calculated to be 0.01% for low, 0.4% for intermediate, and 4% for high-risk groups. The highest yield and most reasonable cost-effectiveness was found only in the high-risk group—those children with headache for <6 months and at least one other predictor of a "surgical space-occupying lesion" including sleep-related headache, vomiting, confusion, absence of visual aura, absence of a family history of migraine, and abnormal neurologic examination.[41]

Conclusions. Data on 605 of 1,275 children from 1 class II and 5 class III studies of children with recurrent headache who had been examined by a neurologist and who underwent neuroimaging found only 14 (2.3%) with nervous system lesions that required surgical treatment. All 14 children had definite abnormalities on examination. No patient with a normal examination had a lesion that required surgical treatment.[36,37]

Recommendations

1. Obtaining a neuroimaging study on a routine basis is not indicated in children with recurrent headaches and a normal neurologic examination (Level B; class II and class III evidence).
2. Neuroimaging should be considered in children with an abnormal neurologic examination (e.g., focal findings, signs of increased intracranial pressure, significant alteration of consciousness), the coexistence of seizures, or both (Level B; class II and class III evidence).
3. Neuroimaging should be considered in children in whom there are historical features to suggest the recent onset of severe headache, change in the type of headache, or if there are associated features that suggest neurologic dysfunction (Level B; class II and class III evidence).

Future research

1. Prospective studies are needed to define the clinical characteristics of headaches in children

that would identify those at risk for serious intracranial disease.

2. Controlled prospective studies with blinded assessments should be conducted to define the role for laboratory investigations in the evaluation of children with acute as well as recurrent headache.
3. Controlled prospective studies with blinded assessments examining the yield of neuroimaging in children with recurrent headaches who have normal neurologic examinations and in children with headache syndromes as defined by International Headache Society Criteria would be clinically useful.

Disclaimer. This statement is provided as an educational service of the American Academy of Neurology and the Child Neurology Society. It is based on an assessment of current scientific and clinical information. It is not intended to include all possible proper methods of care for a particular neurologic problem or all legitimate criteria for choosing to use a specific procedure. Neither is it intended to exclude any reasonable alternative methodologies. The AAN and CNS recognize that specific patient care decisions are the prerogative of the patient and the physician caring for the patient, based on all of the circumstances involved.

Appendix

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