J Headache Pain (2000) 1:137–144

REVIEW

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Co-morbidity of migraine and epilepsy: a review of clinical features

Received: 10 July 2000
Accepted in revised form: 5 October 2000

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Abstract Migraine and epilepsy are common neurological conditions that often co-exist. There are some common symptoms and in some patients there may be a diagnostic problem. The purpose of this study was to review the literature on the co-morbidity of migraine and epilepsy, and to differentiate their clinical characteristics. A search in Medline using the terms 'migraine and epilepsy' was conducted to identify articles published during the period 1963–1999. Articles describing co-morbidity of epilepsy and migraine have been reviewed. In the absence of convulsive episodes or a clearly migrainous profile (especially in children), confusion is most likely in patients affected by transient blindness, paroxysmal abdominal pain, unseen nocturnal events and "basilar" symptoms. Electroencephalographic abnormalities and response to an anticonvulsant may not clarify diagnosis. Although clinicians generally have little difficulty, rarely more investigations may be required for some patients. An isolated, single electroencephalogram may not provide definitive data unless an event is captured during the recording. Clinicians, therefore, have to rely mainly on the interpretation of the patient's history and clinical presentation.

Key words Aura • EEG • Epilepsy • Headache • Migraine • Seizures

Introduction

Migraine and epilepsy are two distinct neurological conditions that are easily distinguished by history and clinical presentation [1, 2]. Typically, migraine is presented as unilateral throbbing headache with no manifestation of the convulsive activity often associated with some seizure types. Nonetheless, both migraine and epilepsy are common and occur respectively in about 16%–24% and 5%–10% of population [3, 4]. It is therefore not surprising that these two conditions often coexist. Confusion may arise when patients present with headaches associated with symptoms similar to those seizure disorders in which there are no convulsive activities, especially if consciousness is preserved or only slightly altered. Furthermore, the interictal encephalograms (EEGs) of many migraine patients contain mild abnormalities [5]. Indeed, it can be difficult to differentiate seizure disorders from migraine phenomena (and vice versa) in some patients. It is particularly a problem in children with atypical clinical presentations with or without abnormal EEGs [2].

The association between migraine and epilepsy is, however, not a new observation and was first reported in 1960s [6, 7]. Since then several research papers and some review articles have been published on this topic, but so far no significant diagnostic guidance has been developed. [8, 9]

The purpose of this study was to carry out a systematic analysis of the co-morbidity of migraine and epilepsy by reviewing published literature on this topic. It is intended to highlight areas of potential confusion and provide some suggestions for investigation of patients with complex clinical history.

We carried out a Medline literature search of papers published in peer-reviewed journals form 1966 to 1999. We used the search strategy 'migraine and epilepsy'. This generated 332 publications and after an initial scrutiny, we selected 112 papers for further analysis. We grouped the papers according to the clinical topics to assess the co-morbidity of migraine and epilepsy.

Situations in which seizures and migraine may coincide

Overall, there are few consistent correlations between seizures and migraine. Savoldi et al. [8] reviewed data from a large group of patients and found a poor correlation between epileptic seizures and headache. Bruyn [9] reviewed genetic, epidemiological, clinical, electro-neurophysiological and neurochemical data from a number of studies and concluded that there were no clear associations between migraine and epilepsy. Nonetheless, there are some situations where seizures and migraine occur within the same individual, and in rare cases there appears to be a direct relationship between the two.

The menstrual cycle, migraine and epilepsy

There are recognised relationships between the menstrual cycle and both seizures and migraine attacks (catamenial phenomenon). Up to 20% of female migraine sufferers show a relationship between headaches and menstrual cycle [10, 11]. This is more common in women suffering from migraine without aura [12, 13]. Similarly, one-third to one-half of women with epilepsy have catamenial seizure patterns, with seizures most likely to occur in the peri-menstrual period and at ovulation [14]. Therefore in women with both conditions, there may appear to be a relationship between the attacks. Marks and Ehrenberg [15] reviewed data from 395 adult seizure patients and reported that patients with catamenial epilepsy and patients with migraine with aura were at increased risks for an association between these two disorders.

Seizures in children

Among children with benign epilepsy with centrotemporal spikes (BECTS), there is a higher than expected incidence of migraine [16]. Septien et al. [17] reported that migraine was present in 81 (63%) of 129 patients with BECTS and that this was much higher than for other types of epilepsy. In an age-matched, controlled study, however, Santucci and coworkers [18] found migraine in only 6 (14%) of 43 BECTS patients; this incidence was not significantly different to that identified in 17 (13%) of 129 control subjects.

Seizures leading to migraine

Probably the most common relationship between seizures and migraine is when migraine-like headaches occur after seizures. Postictal headaches are often indistinguishable from migraine and are equally common in patients with or without a family history of migraine [2]. Ogunyemi and Adams [19] reported 2 patients in whom migraine-like symptoms, similar to their normal migrainous headaches, were triggered by occipital lobe seizure. Schon and Blau [20] reviewed data from 100 patients with seizure disorders and identified 9 patients with both migraine and epilepsy. Eight of those reported that mild migraine attacks were provoked by seizures. Of the 100 epileptic patients they examined, 51 often had postictal headaches with migraine-like features including vomiting and photophobia. These headaches were often prolonged (6–72 h) and relieved by sleep. Schon and Blau [20] went on to suggest that postictal headaches may be in response to vasodilatation normally associated with seizures. Finally, migraine following seizures is distinguished from postictal headache by its long duration and by its association with photophobia, nausea and vomiting.

Migraine leading to seizures

Given the significant neurogenic cortical changes associated with migraine, it may be expected that these changes precipitate seizures. However, this is a surprisingly rare phenomenon. Of the 395 adult seizure patients reviewed by Marks and Ehrenberg [15], 13 (3%) experienced seizures during or immediately following a migraine aura. Two had continuous EEG monitoring that recorded a migraine aura leading into the onset of an electrographic complex partial seizure. Niedermeyer [21] reported 8 young-adult patients with generalised tonic-clonic seizures and independent migraine attacks. The major convulsions were preceded by a typical visual prodroma in 6 of 8 patients, and a full-blown migraine attack followed the convulsion in all patients. Recently Velioglu and Ozmenoglu [22] reviewed data from 412 adult patients with seizure disorders; 58 (14%) also had independent migraine attacks. Seven of those patients had migraine-induced seizures. The seizures began during or shortly after the migraine aura in all cases and preceded the headache.

Overall, however, these situations in which migraine and seizures overlap provide little problem for the clinician because the seizure disorder is clearly apparent. There are other conditions where the differentiation is not so clear.

Circumstances in which patients with seizures or migraine present with similar symptoms

There are rare situations in which a patient with migraine is misdiagnosed as having epilepsy, or vice versa. These situations most often arise in conditions where there is no history of convulsions, and consciousness is preserved or only slightly altered. Differentiation of migraine and epilepsy can be more difficult when examining and taking history from children. This is especially true in young children where a dignosis of migraine is difficult to validate in any objective way [23].

To consider the question of potential confusion between these two entities we shall look at situations where the clinical presentations implying migraine or seizure may be ambiguous.

Presentation: headache

Headache as such does not cause a diagnostic concern. While headaches are a common consequence of seizures, isolated tension-like headaches are not confused with seizures. Problems may arise when the headache is more severe and has unilateral features. Repeated severe headaches that develop relatively slowly (in the order of minutes), have unilateral features and are prolonged (4–72 h), are almost always examples of migraine without aura [24]. Nevo et al. [25] reviewed findings from 312 children referred to an outpatient paediatric neurology clinic for headaches. They found a high incidence of epileptiform EEG activity in 16 (5%) children who presented with brief, rapidly evolving, paroxysmal headaches.

Battistella et al. [26] reported recurrent, pulsating, migraine-like headaches in a young patient with an atypical form of Sturge-Weber syndrome, a condition often associated with epilepsy. In that case, the paroxysmal headache attacks were apparently correlated with parieto-occipital calcifications.

Presentation: visual disturbances

Visual disturbances are the most common feature of migraine with aura and a less common feature of seizure disorders. They may pose diagnostic difficulties in patients with non-convulsive seizures.

Visual hallucinations. Elementary visual hallucinations and headache are features of idiopathic occipital epilepsy, and this condition is sometimes misdiagnosed as migraine [2]. Panayiotopoulos [2] reviewed findings from nine patients with idiopathic occipital epilepsy and in most cases the hallucinations were brief (generally 5–30 s), coloured and of variable simple shapes. Vision was usually only obscured in the region of the hallucination. Wilder Smith and Nirkko [27] also reported a migraineur who presented with recent onset of unusual visual symptoms accompanied by non-specific EEG changes. Such a history is superficially typical of migraine, however her visual disturbance was brief (5–15 s) and involved distorted vision with false colour. Doppler studies confirmed blood flow changes consistent with seizure. The features of the visual hallucinations during these epileptic episodes clearly differ from visual hallucinations occurring with migraine aura. Migraine auras are normally achromatic (or black and white), with zigzag or linear patterns that gradually expand over minutes, often leaving a scotoma [28]. Terzano et al. described an association between migraine and intercalate seizures with occipital EEG paroxysms [29].

Not all subjects with occipital lobe epilepsy present with such clear-cut features. Walker et al. [30] reported a 31-year-old man whose visual hallucinations were of simple flashing lights obscuring his left visual field for a period of 2 days, associated with a severe frontal headache. This phenomenon more closely matches migraine aura, and initially he was diagnosed as suffering from migraine. These events, however, were in fact episodes of simple partial epileptic status that sometimes lead into convulsive seizures. Subsequent detailed investigation revealed the true nature of his attacks.

In general, close attention to the detail of the visual hallucination can differentiate migraine from seizure related events.

Blindness. Transient blindness can be a feature of basilar or retinal migraine. Transient blindness arising from a seizure disorder (either ictal of postictal) is rare but more common in children [31]. Kosnik et al. [31] reported 3 children, all with transient postictal blindness and varying degrees of associated focal convulsions. Aldrich et al. [32] reported a man with transient, and later permanent cortical blindness as a result of a seizure disorder, but this phenomenon coexisted with clear convulsive episodes. Three of the nine patients reviewed by Panayiotopoulos [2] had ictal blindness as their only seizure manifestation.

Migraine-induced transient cortical blindness can be a consequence of the scotoma resulting from the visual aura in migraine. In that case a detailed history may reveal the true nature of the event. Without this, and in the absence of any other seizure phenomenon, it may not be possible to differentiate migraine-induced transient cortical blindness form that induced by a seizure disorder, and so further investigation would be warranted.

Basilar symtomps. Patients presenting with basilar symptoms often present a diagnostic dilemma. Typically, in basilar migraine the symptoms develop slowly (over minutes) and are transient representations of a dysfunction of the brainstem and/or the occipital lobes. They are associated with migrainous headache, there are no convulsive movements and in young patients there may also be a period of acute confusion. Often basilar migraine will resolve over a period of years [2, 33]. Unfortunately the broad range of symptoms are sometimes confused with seizures disorders. This problem may in part be due to occasional sequelae of basilar migraine. Camfield et al. [34] suggested that repeated basilar artery migrainous aurae cause permanent ischaemic damage that expresses itself as a persistent EEG abnormality. De Romanis and colleagues [33, 35] reported some cases where a seizure disorder developed after the basilar migraine resolved.

In cases where the symptoms develop quickly (over seconds), the aurae are not typical of migraine (e.g. coloured shapes), or there are convulsive movements, more extensive investigations may be required to rule out a seizure disorder.

Presentation: confusional state

Confusional state represents an unusual picture which may often be referred to juvenile migraine if characterised by disorientation, psychomotor agitation, and combativeness of varied duration (some hours) accompanied by transient slowing EEG rhythm [36]. Such a picture must be recognised to be different from manifestations of psychiatric origin and from non-convulsive epileptic status.

Presentation: gastrointestinal symptoms

Nausea and vomiting can accompany virtually all forms of migraine and are also common features of seizure disorders. In addition, there may be other associated gastrointestinal symptoms.

Nausea and vomiting. In a review of epileptic patients with postictal headaches, Schon and Blau [20] identified 40 patients that did not have a coexisting migraine disorder; of those, 11 (28%) had postictal vomiting. In childhood, seizures with probable occipital origin, characterised by vegetative symptoms (such as nausea and vomiting) and motor symptoms (such as head and eye deviation), can be considered when making a differential diagnosis of migraine [37]. Nausea is a feature of the aura in temporal lobe epilepsy; up to 20% these patients have visceral aura, epigastric distress, 'rising sensation', nausea, vomiting or salivation [38]. Sometimes the aura is the only clinical expression of temporal lobe epilepsy [38]. Nausea and vomiting in isolation are non-specific symptoms.

Cyclic vomiting and abdominal pain. Cyclic vomiting is not generally associated with any seizure disorder and is a condition predominantly found in children. There is, however, a direct relationship between cyclic vomiting and 'abdominal migraine' [39].

Abdominal pain by itself may be an expression of migraine or a seizure disorder. Abdominal migraine and 'abdominal epilepsy' are both rare, and more common in children than adults [38, 40–42]. Prichard [43] reviewed 19 patients with abdominal pain, of whom 17 had episodes of vomiting or drowsiness, 11 had normal EEGs and 3 had diffuse dysrhythmia. He classified these 17 as having abdominal migraine. Two others with abrupt onsets had spikes on their EEGs, and were considered to have abdominal epilepsy. The distinguishing diagnostic features of abdominal epilepsy were the rapid onset (seconds compared to minutes) and the epileptiform EEG.

Cyclic vomiting by itself is almost certainly not an expression of a seizure disorder. Abdominal pain by itself is more ambiguous. A careful history and an ictal EEG may help.

Presentation: vertigo

Benign paroxysmal vertigo of childhood is classified as a periodic syndrome that may be a precursor to, or may be associated with, migraine [24]. However, isolated vertigo is rarely a manifestation of epilepsy [44]. Aurae of vertigo and dizziness are reported in some seizure disorders, more often of extratemporal origin [45], but generally this condition causes little confusion.

Presentation: hemiplegia

Familial hemiplegic migraine is a well studied phenomenon [46], and transient hemiplegia as a consequence of Todd's paralysis after hemiconvulsive seizures is also known [47]. Transient hemiplegia alone, however, has not been reported as the sole manifestation of a seizure disorder and is therefore unlikely to cause diagnostic confusion.

Alternating hemiplegia of childhood is a rare disorder with a poor prognosis which may coexist with other neurological features including a seizure disorder [48]. It is a unique entity that is unlikely to be misdiagnosed. Benign

familial nocturnal alternating hemiplegia of childhood is even more rare [49], and similarly is unlikely to be misdiagnosed.

Presentation: nocturnal events

Events that arouse patients from their sleep can be difficult to identify, especially in young children. Migraine can arouse sufferers from sleep [50], as can some seizure disorders. Frontal lobe seizures are often nocturnal, sometimes with little or no EEG changes [51]. Furthermore, BECTS can produce minor nocturnal seizures that may arouse the patient or their parents, and those children may have a higher than normal incidence of migraine [16]. This combination may lead to confusion. Prolonged EEG/video telemetry may be the only way to clarify these events.

Presentation: postictal drowsiness

Postictal drowsiness, or sleep, are well-known side effects of seizures. Unfortunately sufferers of migraine usually also resort to sleep to relieve their discomfort. This is not a problem in adults who can accurately report their condition. However, it can be a cause of confusion in young children who may not be capable of accurate reporting, and are sometimes naturally drowsy. Postictal drowsiness by itself in young children is not-specific.

Presentation: epileptiform EEG in migraineurs

A proportion of migrainous patients have clearly abnormal EEG, most often manifested as diffuse dysrhythmia [52]. Some patients with a history of migraine, however, present with clear epileptiform features of paroxysmal sharp waves, spikes, or spike/wave complexes. Deonna et al. [53] reported spikes and waves in 3 of 30 children who had migraine with aura. Kinast et al. [54] looked at the EEG of 100 children presenting with migraine and identified 9 with clear epileptiform sharp waves (but no history of seizures). Talwar et al. [55] reviewed EEGs from 30 children with occipital-posterior-temporal spike-wave paroxysms. Four (13%) children with migraine and no history of seizures had the above-mentioned abnormalities. Schachter et al. [56] reviewed the incidence of spikes and paroxysmal rhythmic events in overnight EEGs of 135 normal adult volunteers. They found spikes in the EEGs of 17 (13%) subjects with migraine and in 18 subjects with a family history of epilepsy. Spikes were observed only in one other normal subject without any history of migraine or epilepsy. These data suggest that epileptiform abnormalities are present in 9%-13% of patients with migraine; this rate is significantly higher than expected for the normal population. We observed a considerably higher incidence of EEG abnormalities in a group of patients with refractory migraine [57]. Thirthy-seven (56%) of 66 patients with or without aura had abnormal EEGs in this study. However, only 67% of them responded to prophylactic sodium valproate therapy [57].

Ricci and Vigevano [58] reported on a migrainous subject who had an occipital seizure in response to intermittent light stimulation. Clear epileptiform waveforms are recorded in some migraine patients and the incidence is higher in patients with hemiplegic migraine [59]. It is normal practice not to introduce anticonvulsant medication. It would be prudent in these circumstances, however, to initiate appropriate investigations and follow-up studies.

Response to anticonvulsants

In the absence of EEG recorded seizures, it is not uncommon to introduce an anticonvulsant if the history is suggestive of a severe problem compatible with a diagnosis of epilepsy. Remission of the suspected events under anticonvulsant medication may indicate that the initial diagnosis of epilepsy was correct. However, there is evidence that in some patients, migraine phenomena also respond to these drugs. Millichap [60] found that a response to phenytoin was insufficient criteria for a diagnosis of epilepsy in children with recurrent headaches where that drug controlled migraine in 32 of 42 (76%) patients. Sodium valproate is now an established prophylactic agent for migraine headache [57, 61, 62]. Similar beneficial effect has also been observed in relation to some new antiepileptic agents [63]. Swanson and Vick [64] reported 12 patients with basilar migraine, and more than half of those responded well to anticonvulsant drugs. Often epileptic patients with a history suggestive of migraine require a combination of both antiepileptic and antimigraine drugs in order to achieve a full control of epilepsy [15].

Conclusions

The aim of this review is to highlight circumstances where there may be confusion in differentiating migraine from seizure disorders. Possible areas where confusion may arise, and the known differences between symptoms of migraine and epilepsy are summarised in Table 1. In most cases, these rarely are a problem, and most neurologists are familiar with

Table 1 Differentiation of some common symptoms of migraine and epilepsy

Symptom	Migraine	Epilepsy	Reference
Headache	Usually unilateral, throbbing headache associated with photophobia, phonophobia, nausea and vomiting	May be postictal and usually is non-specific and generalised. Migrainous headaches may occur in up to 50% of epilepsy sufferers	[24–26, 65, 66]
Visual hallucinations	Typically achromatic or black and white, zigzag or linear patterns expand over minutes and may leave scotoma	Rare. Typically rapid onset, brief, sometimes coloured and simple shapes (e.g. dots)	[2, 27, 28, 30]
Transient blindness	Most often a consequence of scotoma from migraine aura	Rare, more common in children, most often associated with other signs (convulsive seizures)	[2, 31, 32]
Basilar symptoms	Typically develop slowly, associated with migrainous headache. Also some typical migrainous auras. Generally resolve over years	Some reports of basilar migraine preceding onset of epilepsy. some reports of response to anticonvulsants	[2, 33, 35]
Nausea and vomiting	Non-specific	Non-specific	[20–28, 30–35]
Cyclic vomiting and abdominal pain	Rare, more common in children. Cyclical vomiting has been linked to abdominal migraine. Abdominal migraine develops over minutes	Cyclical vomiting is not associated with any seizure disorder. Abdominal epilepsy is rare and may have a more rapid onset (seconds)	[38–42]
Vertigo	Non-specific	Non-specific	[24, 44, 45]
Hemiplegia	Rare. Familial hemiplegic migraine is a recognized entity	Rare. Transient hemiplegia after hemiconvulsive episodes has been reported (Todd's paralysis)	[46–49]
Nocturnal events	Migraine can arouse sufferers from sllep	Seizures can arouse sufferers from sleep	[50]
Postical drowsiness	Non-specific	Non-specific	[52–57]

this topic. However, by focusing on this question we hope to raise the awareness of potential areas of confusion.

As suggested elsewhere, a detailed history and examination are still the best tools for clinician. In general, clinicians should adhere to the diagnostic guidance provided by the International Headache Society (IHS) [24] for migraine and related headaches, and the International League against Epilepsy (ILEA) [65, 66] for seizure disorders. It is the association of symptoms that provides important information: slowly evolving fortification aura, nausea, and throbbing unilateral headache together present a clear picture. If any of these symptoms appear in isolation, then more care is required. Particular attention should be paid to associated events and features of the aura. If the onset is rapid (seconds as opposed to minutes) or if there are associated visual aurae with coloured shapes, then futher investigation is required to exclude epilepsy. Recently, a review concluded that EEG is not indicated in the routine evaluation of patients presenting with headache, except for those patients affected by symptoms suggesting a seizure disorder, i.e. atypical migrainous aurae or episodic loss of cosciousness [67]. In general, a single isolated EEG may not help. Where there is uncertainty, a prolonged EEG that captures a suspected event and neuroimaging investigations may clarify diagnosis.

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