ICTAL AND INTERICTAL EEG ABNORMALITIES IN 100 MIGRAINEURS WITH AND WITHOUT AURA

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Abstract- There are conflicting reports about EEG findings of the migraineurs. In this study we report the ictal and interictal EEGs of 100 migraineurs in comparison with control group. The age range for patient and control groups were 9-48 and 10-46 years, respectively; 32% of the patients were less than 14 years old and the remaining 68% were more than 14 years. In the patient group, 68% of cases had migraine without aura and 32% suffered from migraine with aura. Hemiplegic and basilar migraines were observed in one and two of our patients, respectively. Gender and age had no effect on the type of migraine. Positive family history in first degree relatives was found in 64% of patients, without being influenced by gender or type of migraine. Male to female ratio was 1/1.6 (38/62). Abnormal EEG was found to be much more frequent in migraineurs than the control group (47% vs. 7%). Overall abnormal EEGs were more common in children compared with adult group (53% vs. 44%), though slow discharges were detected more in adult group. The most common abnormality was slow high voltage waves, which was observed in 70% of abnormal recordings. The less common findings, in decreasing order of frequency, were focal (slow, sharps or mixed) discharges in 29%, epileptiform discharges (alone or associated with slow waves) in 8.5%, diffuse beta and frontal intermittent delta activity, each in 2.1% of abnormal recordings. It seems that interictal EEGs do not add further information to the clinical and neurological examination.

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Key words: Migraine, Aura, Electroencephalography, Basilar migraine, Hemiplegic migraine.

INTRODUCTION

Headache is one of the humanity's most common afflictions. The utility of EEG in the diagnosis of headache has been controversial. During the past 50 years, a variety of electroencephalographic abnormalities have been reported in patients with migraine, with an incidence ranging from 11% to 74% (1). Although EEG is not useful in the routine evaluation of headaches, including migraine, it may be of benefit in those headaches which have unusual symptoms, suggesting possible seizure disorder (2, 3). It is also claimed that EEG is clearly indicated in cases with acute headache attacks, when either epilepsy, basilar migraine, migraine with prolonged aura or alternating hemiplegic migraine is suspected (4), keeping the fact in the mind that the final diagnosis must mainly depend on clinical judgment.

A few controlled and blinded studies have shown focal slow activity in 0-15% and spikes in 0.2-9% of patients with migraine, generally not different from control group (5-8). However, spikes are reported more common in migraineurs than in headache-free control subjects by other authors (9). Lauritzen *et al.* and Westmoreland reported slowing, depression of background amplitude and also normal EEG during visual aura of migraineurs (10, 11); others showed definite unilateral intermittent or bilateral delta

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activity during attacks of basilar and hemiplegic migraines (12-14). De Carlo *et al.* reported usefulness of EEG, particularly in children suffering from migraine with aura during ictal phase, because they found abnormalities in 80% of cases (15). Golla and Winter described persistence of photic driving to 20 Hz flashes or above (H-response) in nearly 90% of patients with idiopathic and post-traumatic migraine-like headache and epilepsy, while 80% of headache-free subjects lacked a response above 14 Hz (16). Lack of alpha blocking during intermittent photic stimulation, a trend towards a greater driving response, and an increased alpha power asymmetry are also reported (17-21). Appearance of slow waves and disturbance of consciousness have been reported in classic migraine with different clinical presentations (global amnesia, stupor, clouding of consciousness) (22-24). Lauritzen demonstrated that reduction of cerebral blood flow is not of sufficient magnitude to explain the focal symptoms and also abnormal discharges in classic migraine, rather it may be caused by neuronal dysfunction (25).

In this study we report the ictal and interictal EEGs of 100 migraineurs in comparison with control group.

MATERIALS AND METHODS

This prospective cross-sectional case control study was conducted in our center from January 2004 to November 2005. A total of 100 migraineurs, diagnosed according to International Headache Society (HIS) criteria and randomized from patients referred to clinic of neurology, entered the study. Patients with history of epilepsy, brain lesion and recurrent headaches not compatible with HIS criteria were excluded. We excluded also drug abusers and patients with stupor during EEG recording. Equal numbers of healthy volunteers were chosen as control group. Patients less than 14 years old were considered children subgroup, and those above 14 years old as adult subgroup. We obtained informed consent from all participants.

Ages, gender, family history, types of migraine as well as EEG abnormalities were evaluated. EEG was performed, whenever possible, during headache (ictal phase) and between attacks of headaches (interictal phase). Recording were performed by a 21 channel Nehocoden machine, using the international 10-20 system. Each recording session lasted for a minimum 30 minutes, with 3 min of hyperventilation (HV) and intermittent photic stimulation (IPS) with a flash frequency ranging from 1 to 30 Hz as described by Golla and Winter (16). The EEGs were evaluated and then reevaluated by another experienced physician, blinded to the patient's identities. EEGs were recorded ictally (within 48 h of onset of the headache) in 14 cases, and interictally (5-10 days after attack of migraine) in the remainder 86 patients. Although a pronounced slowing during HV has often been considered in migraine, this response develops also in healthy individuals, so we decided not to use the slowing during HV in this study.

Data were gathered and analyzed by SPSS software using Fisher's exact X^2 test. $P < 0.05$ was accepted as being statistically significant.

RESULTS

The age range for patient and control groups were 9-48 (mean: 26 ± 1.8) and 10-46 (mean: 23 ± 2.1) years, respectively. The ratio of children to adults and also migraine with aura (MWA) to migraine without aura (MWOA) were in both 1:2.1 (32/68). With regard to age-subgroups, we detected that 10 cases among the children and 22 patients among the adults had MWA, whereas 16 cases in the children group and 52 cases of adults suffered from MWOA, indicating that age was also ineffective on the type of migraine (Table 1; *P*, 0.41).

Table 1. Frequency of MWA and MWOA in the children and adults ($P = 0.41$)

	Children		Adults		Total	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
MWA	10	31.2	22	68.8	32	100
MWOA	16	23.5	52	76.5	68	100

Abbreviations: MWA, migraine with aura; MWOA, migraine without aura.

Table 2. Frequency of MWA and MWOA in male and females (P = 0.94)

	Male (n = 38)		Female (n = 62)		Total	
	Number	Percent	Number	Percent	Number	Percent
MWA	12	37.5	20	62.5	32	100
MWOA	26	38.2	42	61.8	68	100

Abbreviations: MWA, migraine with aura; MWOA, migraine without aura.

Male to female ratio was 1:1.6 (38/62). Male to female ratio in patients with MWA and MWOA were 12/20 and 26/42, respectively, thus gender also had no effect on the type of migraine (Table 2; *P*, 0.94). Family history for first degree relatives was positive in 64% of patients, 21 of whom had MWA and the remaining suffered from MWOA, thus the type of migraine had no statistically significant effect on the positive family history (P = 0.81).

Abnormal EEG was found much more frequently in migraineurs than the control group (47% vs. 7%) (Table 3, P = 0.00); 18 cases with abnormal EEG had MWA and remaining 29 suffered from MWOA, suggesting that there was no relation between type of migraine and rate of abnormal EEG (Table 4, P = 0.20). Male to female ratio in patient and control groups with abnormal EEG were 18/29 and 3/4, respectively, confirming that gender also had no effect on the rate of electroencephalographic abnormalities, but age of patients was somewhat an effective factor, because children to adult ratio in patient group was 32/68 whereas it was 20/80 in control group, on the other hand 17 cases in patient group and 3 cases in control group were less than 14 years old, so with a P value of 0.029 there was a meaningful relation between the age and abnormal EEG (Table 5).

Interictal EEGs were abnormal in 41% (36/86). Slow discharges (focal, hemispheric, bilateral) were detected in 33% of patient group and 4% of control groups, thus with a P value of 0.000 it was statistically meaningful. From 33 cases with slowing, 21 patients were adults, in other words 60% of slow discharges had occurred in the adult group, thus it was also age dependent (*P*, 0.03), but neither gender nor type of migraine were effective on the rate of slowing. Many of the patients had more than one type of abnormality in their EEGs.

Table 3. Frequency of abnormal EEG in patient and control groups (P = 0.000)

	Abnormal		Normal		Total	
	Number	Percent	Number	Percent	Number	Percent
Migraineurs	47	47	53	53	100	100
Control	7	7	93	93	100	100

Table 4. Frequency of abnormal EEG in MWA and MWAO (P = 0.20)

	Abnormal		Normal		Total	
	Number	Percent	Number	%	Number	Percent
MWA	18	56.2	14	43.8	32	100
MWOA	29	42.6	39	57.4	68	100

Abbreviations: MWA, migraine with aura; MWOA, migraine without aura.

Table 5. Frequency of abnormal EEG in the age subgroups (P = 0.029).

	Patient group		Control group	
	Number	Percent	Number	Percent
Children	17 (from 32)	53	3 (from 7)	43
Adult	30 (from 68)	44	4 (from 7)	57

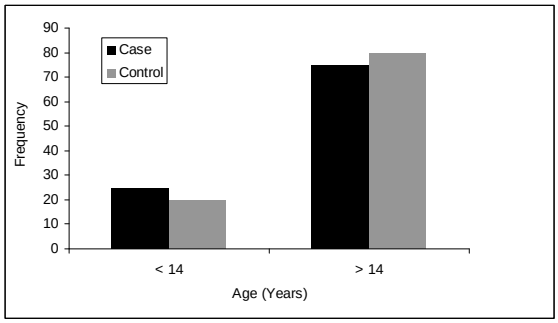

Fig. 1. Frequency of the range of age in patients with migraine and in control group.

The most common abnormality was slow high voltage waves, which was observed in 33/47 (70%) of abnormal recordings. Two-third of them was located over occipital region, ipsilateral to the side of headache. The less common findings, in decreasing order of frequency, were focal (slow, sharps or mixed) discharges in 14/47 (29%), epileptic form (alone or associated with slow waves) in 4/47 (8.5%), diffuse beta and frontal intermittent delta, each in 1/47 (2.1%) of abnormal recordings. Five of the EEGs with lateralized slowing were associated with interhemispheric asymmetry of alpha amplitude (Fig. 1-4). Focal discharges (slow or sharps) were observed in 14% of migraineurs and in 2% of control group, which was meaningful (P = 0.001), and located mostly over occipitotemporal region ipsilateral to the side of headache in patients with unilateral headache. We noticed that 9/14 patients with focal discharge were male, whereas this feature was 1/1 in the control group, thus masculinity had a relation with focality of the discharges (P = 0.029), but five out of nine patients with focal discharges were less than 14 years old, so age was ineffective on the rate of focality (P = 0.37).

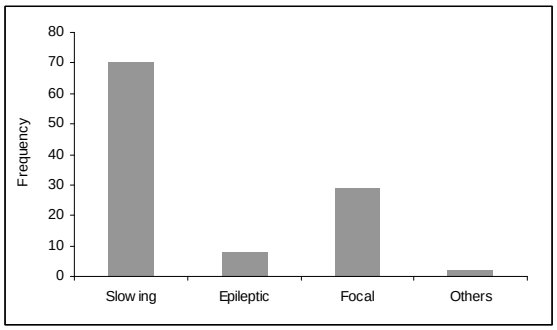

Fig. 2. Frequency of the different types of EEG abnormalities in migraineurs.

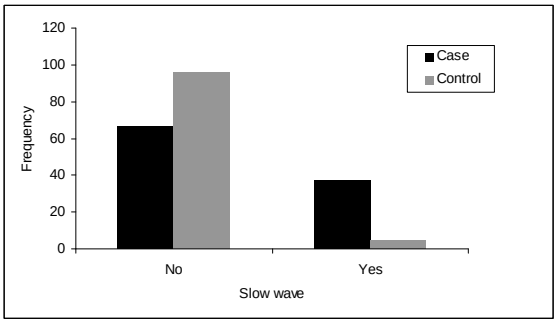

Fig. 3. Frequency of slow wave in patients with migraine and in control group.

Epileptiform discharges were detected in only 4% of patients (8.5% of abnormal EEGs), without any relation to gender, age or type of migraine. H-response was detected in 21% of patients, and we noticed no obvious alpha blocking during IPS.

DISCUSSION

From welter and confusing reports, we understand that protean and non-specific abnormalities may build up in the EEG of migraineurs. On the other hand, diversity of findings may be a mine-field for uncritical physician, particularly in differentiating migraine from epilepsy, especially in children. The problem lies mainly in the high incidence of abnormalities including epileptiform discharges, found in 22-47% of children and adolescents with migraine (26, 27). Although it is doubtful that the EEG exceeds clinical judgment in separating migraine from epilepsy, in some situations the conditions are entwined, as in the syndromes of basilar migraine, visual phenomena, occipital spikes and seizures.

Previous studies have reported slowing with an interhemispheric asymmetry of the alpha rhythm, in the interictal (between headache attacks) EEGs of both MWO and MWOA (28-30). In our study slowing was found in 33% of patients which is nearly twice that of previous reports and only five of them (all with aura) showed obvious alpha asymmetry. Slowing was more frequent in adults and occurred both in ictal and interictal EEGs. Schoenen and Pisani did not report slowing during interictal phase of the migraineurs (31, 32). Women had more slowing in some reports (32) but our study did not confirm this issue. Epileptic activity is the

most intriguing abnormality in migraineurs, which has been reported in 0.4% to 20% of cases (29). These abnormalities include focal and generalized high voltage spikes and spike-wave complexes suppressed by eye opening and have been observed in migraine with visual aura, basilar migraine, childhood epilepsy with occipital paroxysms and benign rolandic epilepsy (26, 34-35). Four of our patients had epileptiform discharges (8.5% of abnormalities) which correlate with the least rate of the previous studies.

To differentiate attack of migraine from epilepsy, Panayiotopulos concluded that if each characteristic of visual aura is identified, the diagnosis of migraine is easy (36, 37). Brinciotti showed that the presence of specific clinical features (amaurosis, scotoma and positive family history) together with bilateral EEG abnormality and no changes during IPS is related to migraine (38). In a recent study periodic lateralized epileptiform discharges (PLEDs) were reported (39). Our patients with epileptiform discharges did not show any PLEDs pattern. Basilar migraine is usually first encountered during childhood or teenagers. Several types of abnormal EEG were reported in basilar migraine including 1) an excess of beta activity in the ictal phase in children (40), 2) predominant delta activity during attack of headache and normal EEG between the attacks (41), 3) slowing in posterior region or slowing with spikes and sharp-wave complexes (42-44), and 4) unusual association of acute confusional state with FIRDA (frontal intermittent rhythmic delta activity) during attack of migraine (44). We had two patients suffering from basilar migraine; one of them showed diffuse beta activity with the absence of alpha rhythm during headache and the second one had frontal intermittent slow activity. We have no explanation for the latter finding.

In conclusion, our study showed that there was no significant variation between EEGs of MWA and MWOA, and that interictal EEGs did not add further information to the clinical and neurological examination. We also noticed, in contrast to Pisani *et al.* (32), that most of patients had abnormal interictal EEG (41%), and despite the fact that abnormal EEGs were found more frequently in children, slowing is more frequent in adults compared to children.

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Conflict of interests

The authors declare that they have no competing interests.

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