Epilepsia, **42**(9):1180–1184, 2001
Blackwell Science, Inc.

Hot Water Epilepsy: Clinical and Electrophysiologic Findings Based on 21 Cases

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Summary: *Purpose:* Our aim is to outline the clinical and electroencephalographic (EEG) features of patients with hot water epilepsy (HWE), a rare and unique form of reflex epilepsy.

Methods: Twenty-one patients with HWE, seen in our clinic until 1999, were studied. Male outnumbered female subjects in a ratio of 3:1. The age at the onset of seizures ranged from 19 months to 27 years (mean age at onset, 12 years).

Results: The main factors precipitating seizures were bathing with hot water and/or pouring water over the head. Six patients reported self-induction, either by increasing the heat or the amount of water and/or recalling earlier bathing experiences. Nine patients expressed feeling pleasure during the seizures. Twenty patients had partial seizures, eight of whom also had secondarily generalized seizures. One patient had apparent generalized seizures only. Spontaneous seizures were present in 62% of the cases. Interictal epileptogenic abnormalities were documented in the EEGs of eight patients; the other eight had normal EEGs. The major sites of epileptogenic activity were over the unilateral temporal regions (in 40% of patients). Neuroimaging studies available for 12 patients (four cranial computed tomography and eight cranial magnetic resonance imaging scans) revealed normal findings. Seizure control in patients who were followed up was achieved by reducing the temperature or the duration of the bath or shower; several of the patients required medication.

Conclusions: The major findings of this study are that HWE has a male preponderance, can be self-induced, is often done for pleasure, has complex triggering factors, and shows temporally located abnormalities in the EEGs. Although HWE is generally known to be self-limited, antiepileptic drug treatment may sometimes be necessary to control seizures. Hot water epilepsy should be classified separately among the epileptic syndromes. **Key Words:** Reflex epilepsy—Reflex seizure—Hot water—Self-induction.

The term ''reflex epilepsy'' describes a seizure precipitated by an external sensory stimulus. The role of stimuli in provoking seizures has been known since the 1850s; several types of seizures have been described since then (1). Seizure precipitation by hot water during bathing was named "hot water" or "bathing" epilepsy. I. M. Allen (2), in 1945, first described a 10-year-old boy who had seizures during bathing. Isolated and rare case reports followed from Australia, Japan, Canada, and the United States (3–6), and a small series of patients with hot water epilepsy (HWE) was reported from Turkey (7). In contrast to the isolated case reports, Mani et al. (8) reported a series of 108 cases from India in 1974. The largest series, of 279 patients, was reported from southern India by Satichandra et al. (2). In that region, HWE was reported to account for 3.6–3.9% of all epilepsy cases. Speculation about the possible reasons for this high incidence included genetic factors and the high temperature of bathing water (2,9).

An interesting point is that the reports from south India found a higher frequency of HWE in Muslims (2,8). In this study, we report the clinical and electroencephalographic (EEG) findings of 21 patients from Turkey, where Muslims are predominant, with seizures precipitated by bathing with hot water.

PATIENTS AND METHODS

Records in our epilepsy unit, up until 1998, indicate that 101 patients had reflex epilepsy. Of these, 13 had HWE, 22 had startle epilepsy, 64 had photosensitive epilepsy, and two had eating epilepsy (10). Whereas the 13 patients with HWE were seen over a period of 12 years, eight new cases came to our outpatient clinic in 1999 alone, probably because of our widely known interest in HWE.

Revision accepted June 1, 2001.

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This work was presented in part as a poster in the 23rd International Epilepsy Congress in Prague, September 1999.

As a result, 21 patients who had seizures during bathing were studied. The personal and family medical histories, neurologic findings, EEGs, and neuroimaging results of the patients were reviewed. The essential criteria for diagnosis were the clinical histories of the patients. Seizures were classified according to the commission of the International League Against Epilepsy (11).

Ictal recordings were not done for any of the patients because of the difficulty in provoking such a reflex seizure in laboratory conditions. One patient who induced seizures by putting his hands into water and exposing his face to raindrops was in remission. His family preferred to clean the boy with a wet cloth and would not consider an ictal recording.

The mean age at admission was 19 years (22 months to 38 years). Follow-up ranged from 1 to 16 years for 15 patients, with a mean duration of 4.6 years. The other six patients refused follow-up investigations or treatment because of social factors or because they lived too far away from the medical center.

RESULTS

The age at onset of seizures ranged from 19 months to 27 years (mean age at onset, 12). In 57% of the patients, the age at the onset was within the first decade of life (1.5–11 years). Male-to-female ratio was 3:1. The percentage of patients with HWE among all patients with epilepsy was 0.6%.

Among the 21 patients with HWE, 20 had partial seizures with simple and/or complex symptoms. Eight of these patients had secondarily generalized seizures. One patient had clinically generalized seizures without any known partial features (Table 1). Eight (38%) of the patients had their seizures only during bathing, whereas the remaining 13 (62%) had additional spontaneous seizures. None of these 13 patients had spontaneous seizures before the onset of their reflex seizures. In five of these 13, spontaneous seizures began within a period <1 year after the onset of reflex seizures; in the other eight patients, spontaneous seizures began within a mean duration of 9.6 years (2–20 years) after the onset of reflex seizures.

In patients 3, 14, 17, 18, and 20, the spontaneous seizures were secondarily generalized and occurred primarily during sleep.

With the exception of the patient with generalized seizures (patient 6), all others had auras preceding their seizures. These auras, described in Table 1, were significantly associated with the onset of temporal lobe seizures.

TABLE 1. *Clinical and laboratory features of the patients*

Pt. No.	Sex	Age at admission (yr)	Age at seizure onset*	Seizure type	NE	Auras	Interictal EEG	CT/MRI	AED	Age at remission	Follow-up duration (yr)
1	M	38	23 (23)	CP	N	Remembering the past	N	NP	CBZ	38	1.5
2	F	6	3 (3)	CP	MR	Staring, oral automatism	N	NP	CBZ	Unknown	0
3	M	32	20 (32)	SP	N	Feel like fainting	N	NP	No tx	Unknown	0
4	M	28	27	CP	N	Feeling a fondness for bathing, remembering being washed by mother	Bi FT sw-pa in HV	NP	No tx	28	1
5	M	30	7 (25)	SP-CP	N	Sound of bowl during bath, image of newspapers scattered on bathroom floor	N	NP	No tx	Unknown	0
6	F	22 mo	19 mo	GC	N	None	Generalized theta	N	PB	Unknown	0
7	M	11	11	CP	N	Feeling of living in future	L TP sw-pa	N	No tx	13	13
8	F	16	16	CP	N	Passing out	N	NP	PHT	Unknown	0
9	M	20	8 (9)	SP-CP	N	Smell of coal	Not performed	NP	No tx	Unknown	0
10	M	5	1.5	GC-CP	N	Unconscious	N	NP	PB	6	11
11	M	16	4 (4)	SP-CP	N	Blackout, dizziness	Bi T sw-pa	NP	CBZ	17	5.5
12	M	11	4 (7)	CP	MR	Unconscious	L T sw-pa	N	CBZ	14	7
13	M	6	3 (6)	SP-CP	N	Visualizing insects, snakes	L FT sw-pa	N	CBZ, No tx	7	16
14	M	27	26 (26.5)	GC-CP	N	Relaxation, calmness	R FC theta	N	No tx	28	1.5
15	M	27	23	GC-CP	N	Remembering childhood memories	L TO sw-pa in HV	N	No tx	27	1
16	F	22	18	SP	N	Feel like fainting	Bi FT theta	N	No tx	23	1.5
17	M	29	11 (25)	SP-SGC	N	Déjà vu, dizziness, blackout	N	N	CBZ, No tx	29	1
18	F	20	15 (20)	SP-SGC	N	Calmness, feel like moving in slow motion	N	N	BDZ, VPA	20	1.5
19	M	14	14	CP-SGC	N	Bad taste in mouth	R TO sw-pa	N	No tx, CBZ	14	1
20	M	24	5 (25)	SP-SGC	N	Feeling a mixture of pleasure and pain, unconscious	R TP sw-pa	N	No tx	26	4
21	M	12	10 (12)	CP-SGC	N	Epigastric sensation	R FT theta	N	VPA	12	2

NE, neurologic examination; EEG, electroencephalograms; CT, computed tomography; MRI magnetic resonance imaging; AED, antiepileptic drug; M, male; CP, complex partial; N, normal; NP, not performed; CBZ, carbamazepine; F, female; MR, mental retardation; SP, simple partial; tx, treatment; Bi, bilateral; FT, frontotemporal; sw-pa, sharpwave and paroxysmal activity; HV, hyperventilation; GC, generalized convulsion; PB, phenobarbital; L, left; TP, temporoparietal; PHT, phenytoin; T, temporal; R, right; FC, frontocentral; TO, temporooccipital; SGC, secondarily generalized convulsion; BDZ, benzoctiazepine; VPA, valporoic acid; Pt, patient number; yr, year; mo, month.

*Numbers in parentheses indicate age of onset of spontaneous seizures.

Traditionally, Turkish people bathe by sitting and pouring hot water from a washtub or basin over their heads with a bowl. The bathing habits of our study group were similar. Pouring water over the head was described as the most frequent precipitating factor (n = 14) of seizures. Other triggering factors, which were reported either to accompany the pouring or to occur in isolation, were the heat of the water, the amount of water, the duration of bathing, touching the water onto one's body or face, terminating the bath, and bathing in one's own bathroom. One patient described a complex of triggering events that included pouring water over his head, hearing the sound of the water, or ending the bath. One patient's triggering events included putting his hands in water or having raindrops touching his face.

Nine patients expressed feeling pleasure during the seizures. These experiences could be simple, such as enjoying the feeling of fainting or hearing the sound of water. Other described more complicated feelings of ecstasy associated with, for example, being washed by one's mother and recalling her utterances, remembering the smile of a woman on television, or seeing an image of newspapers scattered on the floor. These patients enjoyed the memories evoked by the seizures, and they enjoyed living with their seizures.

Six patients reported that they induced the seizures themselves, either by increasing the amount or the heat of water applied to the head or body or by recalling bathing rituals during childhood. Patient 20 induced his seizures compulsively.

EEG and neuroimaging findings

Neurologic examination of all patients was normal, with the exception of two who were mildly retarded.

EEG findings were normal in eight patients. Interictal epileptogenic changes were evident in eight patients, and nonepileptogenic abnormalities were detected in four patients. One patient refused an EEG. In six patients, epileptogenic abnormalities were localized at temporoparietal (n = 2), temporooccipital (n = 2), temporal (n = 1), and frontotemporal (n = 1) regions. In the remaining two patients, bilateral temporal involvement with a right predominance and bifrontotemporal epileptogenic activities induced by hyperventilation were detected. Focal epileptogenic EEG abnormalities, mostly over the temporal regions, were detected interictally in eight (40%) of the 20 patients. Among four patients with nonepileptogenic abnormalities, slow-wave activity within theta range was present either diffusely bilaterally or over bifrontotemporal, right frontocentral, or right frontotemporal regions. Seizure semiology with nonlocalizing auras matched temporal regions when compared with these EEG findings, but no particular lateralization was detected for auras.

Neuroimaging data included computed tomography (CT) in four patients and magnetic resonance imaging (MRI) in eight patients. All scans revealed normal findings. Neuroimaging investigation could not be done in the remaining patients because of lack of consent or refusal of follow-up.

Medical and family history

Medical histories of the patients included complicated delivery (n = 2), mental retardation (n = 2), postnatal head trauma (n = 2), and febrile seizures (FSs) (n = 2). The patients with FSs had no provoked seizures in their later ages. Family history included FSs in two siblings of two patients without FSs (patients 6 and 8) and epilepsy in family members of five patients (15, 17, 19, 20, and 21), two of whom had HWE (one uncle and one cousin). None of the patients and their families had a history of FS-plus syndromes. The patients with spontaneous seizures had no seizures provoked by fever.

Treatment

Seven patients (patients 4, 7, 14, 15, 16, 19, and 20) were followed up without antiepileptic drug (AED) treatment; their seizures were controlled by avoiding hot water or long showers. However, patient 19 induced his seizures compulsively. As a result, he was given carbamazepine (CBZ) 400 mg/day; he remains seizure free.

Five patients (1, 11, 12, 13, and 17) were given treatment of CBZ, 200–600 mg/day. Patients 1 and 11 were in remission under medication. The HWE of patient 12, who was mentally retarded, was controlled with CBZ, 400 mg/day; however, his spontaneous seizures were not controlled until CBZ was increased to 800 mg/day. Patients 13 and 17 stopped taking medication after being seizure free for 1 year; their remissions continue.

Phenobarbital (PB), 100 mg/day, was given to patient 10. After a remission period of 4 years, treatment was discontinued. Patient 18 was prescribed 10 mg diazepam (DZP) rectally 30 min before every bath. She was seizure free for 2 years until an incident during sleep, when she dreamt that she was bathing. She was then treated with 500 mg/day of sodium valproate (VPA). She has had no seizures for the past 6 months. Patient 21 received VPA, 750 mg/day, and has had no seizures for 2 years. The remaining six patients could not be followed up.

DISCUSSION

Patients with HWE seem to have some common characteristics, particularly in regard to gender, age at onset, triggering factors, seizure type, self-induction, compulsive behavior, and response to treatment.

A preponderance of men is consistent in reported series (2,9,10) and in our study. Nearly all studies, except one with a female frequency of 67% (4), reflect ratios

⩾70% for men. The reason for this is not yet known. No sex linkage has been proposed in a study on pedigree analysis of four families with HWE (9,12).

According to our present study, seizures precipitated by hot water are not limited to infancy and childhood, but most are seen in the first decade of life. The age at onset of seizures in our study ranged from 19 months to 27 years, with a mean age of 12 years. In the series described by Satichandra et al. (2), the age at seizure onset was between 2 months and 58 years (mean age, 13.4 years). In another study, the mean age at seizure onset was 4.7 years (7).

According to the data from southern India, HWE seems to account for 3.6–3.9% of patients with epilepsy being studied (1,2). Our series found the incidence to be 0.6%. The condition seems to be very scarce in western cultures (9,10). Although there may be possible genetic explanations for these discrepancies, bathing habits also may be a factor. Although many people in Turkey are moving away from traditional bathing customs, a considerable portion of the population prefer using very hot water, pouring water from a bowl onto their heads, and staying for a long time in highly heated bathrooms. As a result, we have observed that in Turkey, HWE is not related to religious and ethnic differences, but rather to bathing habits.

The most frequently described precipitating factor for seizures in our study was pouring water over the head, although our patients mentioned other factors as well. Multiple specific stimuli seem to play a role in seizures, at least in some of the patients. These stimuli include particular ways of applying the water (i.e., pouring from a bowl), or exposing certain parts of the body (i.e., head, face, or neck) to water, or the heat of the water, or the termination of the bath. Some patients expressed even more complicated conditioning procedures, such as recalling vivid memories or reliving a past scenario, that are not fulfilled except in their own bathrooms.

Regarding the seizure semiology of HWE, partial seizures are outstanding as the dominant feature (2). In our study, 20 of 21 patients had partial seizures with or without secondary generalization, and most of the seizures had complex symptoms (71%). Two studies reported the incidence of complex partial seizures in HWE to be 67% (2) and 80% (8). In one study, 60% of patients with HWE had generalized seizures (7). In our series, 62% of patients had spontaneous seizures in addition to HWE. In other studies, the incidence of concomitant nonreflex seizures has been reported to be 25.4% (2), 16% (8), and 100% (4).

Nearly half of our patients (42.85%) reported feeling pleasure during their seizures, and nearly one third (28.6%) triggered their seizures themselves. This is certainly higher than the report of self-induced seizures from south India (10%) (9). Possible explanations for the differences in these numbers might include the conditions under which the histories of the patients were taken. Feelings of guilt may accompany self-induced seizures associated with enjoyment, which could result in patients hiding their feelings from investigators. Because we tried to encourage empathy between the doctor and the patient, our numbers might be higher than those in other studies (12).

A well-known and remarkable feature of reflex epilepsies is that some patients have compulsive behavior (13). Patients with photosensitive epilepsy may have compulsive attraction to the sun or to bright lights. "Sunflower syndrome," in which the head is slightly bent backward when staring at the sun or at bright light and there is an irresistible attraction toward these stimuli, is an example of this phenomenon (13). We observed that the compulsive desire to trigger seizures is also seen in patients with HWE.

Supported by the imaging data available in our study, and also by the results from comparable studies, it appears that patients with HWE do not have cerebral lesions or serious EEG changes except for ictal recordings (5,6). However, temporal localization for ictal (14) and interictal changes (9) may provide some support for the complex-partial nature of seizures in HWE.

In a well-documented study on rats, repeated hot-water stimuli were shown to have a kindling-like effect, most notably on the amygdala, which produced progressive increases in convulsive responses to stimulation (15,16)

A family history of HWE has been reported in 7–18% of Indian probands (2,8,17). In our series, family history of epilepsy was 25% and of HWE was 10% (patients 2 and 12). Except for one study with contradictory results (18), the literature emphasizes considerable coexistence of FS in the personal and family histories of patients with HWE (9). Whereas the rate of FSs in patients with juvenile myoclonic epilepsy is 12% (19), its rate in patients with HWE was 9.52% in our group. In our opinion, there is not a causal link between HWE and FSs. Rather, the association might reflect a genetic predisposition. These percentages are almost the same in all idiopathic partial epilepsies (20).

Although HWE is generally known to be benign and self-limited, treatment with AEDs may sometimes be necessary to control seizures. First, precautions against precipitating factors must be taken in patients with reflex epilepsy but with no spontaneous seizures. In our patients with spontaneous seizures, low-dose monotherapy sufficed. (When patients were referred to our center, no standard treatment protocol was applied, even if some patients were taking medication at the time.) CBZ was our first-choice drug, but PB and VPA in low doses were effective in three patients. Treatment was also necessary for compulsive self-stimulation, raising the issue of

whether compulsive attraction is an aura for seizures. Our data conform to the literature in this regard (2). We also observed that a low dose of an AED controls the reflex seizures, but does not prevent spontaneous seizures.

With a thorough history, it is quite easy to differentiate HWE from syncope and other seizure events. Partial-seizure symptoms are present in most patients. Unlike other reflex epilepsies such as startle epilepsy, HWE does not occur right after the stimuli but has a longer latency period. The triggering event is complex but is not unexpected and sometimes is even desired. The touch of water to the skin, the temperature of water, and the ambience of the bath may together trigger the seizures. Hot-water seizures are completely different from the other situation-related seizures that last for years and are triggered by an external stimulus. In our study, no additional pathology was detected in HWE as in other idiopathic epilepsies

In conclusion, HWE seems to be a benign, clearly partial form of reflex epilepsy resembling primary reading epilepsy in the complexity of the triggering events and the longer latency observed. Consequently, we believe that the special characteristics of HWE should be classified separately among the epileptic syndromes, perhaps among idiopathic partial-stimulus epilepsies.

Illustration of a case: (patient 20) 27-year-old man

. . . . That change in me, which I call "the trance state" started at ages 4 to 5, when my mother would wash me. The water was always very hot, and when I complained, my mother responded, "It is much better than catching cold in cool water." This unpleasant event started to become tolerable over time, and later became necessary for me; it resulted in a feeling of pleasant exhaustion. . . . I do not remember such episodes during primary school years. Around high school years, I developed ways of triggering my trance state. I would direct the hot water to my neck and back, focus my gaze on a fixed point on the white ceramic wall, repeat my mother's words in the old bathing days, silently to myself (but as if I were hearing those words from somebody else). I would get increasingly pleased but exhausted, and then would sit down on the side of the bathtub with no more power to keep standing. I used to feel terribly nervous and anxious if some kind of disrupting stimulus would interfere with the event. . . . Sometimes I had to try over and over again. During the university years, I started to feel guilty, and tried ways of getting rid of this situation. . . . Those were the years that I used to exert more energy to pass out and got more exhausted than before. . . . I then realized that I could faint. . . . I would feel no dizziness, but feel nausea and would vomit in some of those episodes. . . .

This patient had three secondarily generalized seizures during bathing, which caused him to be taken to the emergency unit of a nearby hospital. He did not reveal the information about self-triggering until specifically questioned after his second major episode.

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