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Use of postictal respiratory pattern to discriminate between convulsive psychogenic nonepileptic seizures and generalized tonic-clonic seizures

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ABSTRACT

Distinguishing between generalized tonic-clonic seizures (GTCSs) and convulsive psychogenic nonepileptic seizures (PNESs) can be difficult at the bedside, and this distinction has important implications for patient care. This study used a fully blinded method to examine postictal breathing parameters to identify features distinguishing between generalized tonic-clonic seizures (GTCSs) and convulsive psychogenic nonepileptic seizures (PNESs). Three blinded readers examined edited video recordings of the postictal phase of 72 convulsive seizure episodes recorded from 56 patients. There were 59 GTCS episodes and 13 PNES episodes. Postictal breathing after a PNES episode was more rapid than after a GTCS episode and, thereafter, normalized more rapidly. Postictal breathing after a GTCS episode was more likely to be characterized by stertorous respirations. Postictal breathing after a PNES episode was very unlikely to be characterized by stertorous respirations. Postictal respiratory pattern can assist in discriminating between GTCS and convulsive PNES.

1. Introduction

Epilepsy is a common condition resulting in morbidity for patients through injuries, side effects from prescribed medications, and repeated hospital presentations resulting in invasive and noninvasive investigations [1].

Distinguishing between generalized tonic-clonic seizures (GTCSs) and convulsive psychogenic nonepileptic seizures (PNESs) can be difficult even for skilled neurologists. Incorrect identification can result in patients being exposed unnecessarily to invasive investigations and potentially hazardous treatments [2]. Seizure remains a common presenting problem in emergency departments [3], and patients are often managed by medical teams other than neurology services [4]. Any diagnostic test which helps distinguish PNES from GTCS at the bedside is, therefore, potentially useful for acute care clinicians.

Attempts have been made to try and identify those features which help in discriminating PNES from GTCS. There are a number of seizure characteristics which have been found to be predictive of PNES. These include purposeful, asynchronous, apparently consciously integrated motor activity, ictal moaning, as well as unresponsiveness without predominant motor symptoms [5]. Other features suggestive of PNES include gradual seizure onset [6], pelvic thrusting [7], resisted eye opening [8], and ictal crying [9].

Within the Auckland City Hospital epilepsy monitoring unit, it was noted that the postictal respiratory patterns of patients with convulsive PNESs and with GTCSs were often different. This has been examined directly in an unblinded fashion by looking at patients with known generalized tonic-clonic seizures, patients with psychogenic seizures, and patients with frontal hypermotor seizures [10]. This study concluded that the postictal breathing pattern helped in discriminating between epileptic tonic-clonic seizures and nonepileptic convulsive seizures. Patients with epileptic seizures exhibited a deep, regular postictal respiratory pattern, while those with nonepileptic seizures had a shallow, quiet pattern. Postictal respiratory rates also helped in discriminating between those with nonepileptic seizures and those with epileptic seizures. A lack of blinding was noted as a limitation of this study, and this was thought to be difficult to overcome as the nature of the seizure may influence the reader.

The purpose of our study was, therefore, to examine postictal respiratory patterns in patients with generalized convulsive motor seizures, with the readers being blinded to the nature of the seizure itself.

2. Method

All patients undergoing video monitoring at the Auckland City Hospital signed a consent form, agreeing that the recordings can be used for audit and research work. All adult patients who experienced a GTCS or a convulsive PNES resembling a generalized seizure while undergoing video monitoring between October 2000 and March 2009 were identified, and an edited videotape comprising the final 5 s of the seizure

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Table 1

Total number of patients				Total number of events
	Male	Female	Total	
Primary GTCS	2	1	3	3
Secondary GTCS	25	18	43	56
PNES	2	8	10	13
Total	29	27	56	72

NB. One male patient had a secondary GTCS as well as a PNES.
PNES (psychogenic nonepileptic seizure), GTCS (generalized tonic-clonic seizure).

followed by 10 min of the postictal phase was created. The final 5 s of the seizure was included to ensure that the reader could commence counting immediately on the cessation of the seizure. We believe that viewing this brief segment would not introduce any bias and would improve the accuracy of the recording. These recordings were viewed independently by three readers (a neurologist, a neurology registrar, and a respiratory registrar) who were all blinded to the nature of the patients' seizures.

The respiratory rate was counted for one full minute at two-minute intervals (0 to 1 min, 2 to 3 min, 4 to 5 min, 6 to 7 min, and 8 to 9 min). The presence or absence of postictal snoring was also recorded. Once the reader had determined that the respiratory rate had normalized, she/he did not count further.

The time it took for the patient's respiratory pattern to return to normal was recorded. This parameter was a subjective composite comprising the time taken for the respiratory rate to return to normal as well as the impression that the respiratory effort had returned to baseline. This result was recorded as being at 0, 2, 4, 6, or 8 min.

The results were recorded on separate recording sheets, and the lead author collated the results. Median respiratory rates were calculated for each patient at each time interval. Analysis was done using unpaired (two-sample) *t*-test. The episodes were independently identified as epileptic or PNES by an epilepsy specialist reviewing the report generated at the time of the investigation.

3. Results

Fifty-eight patients were identified as having had a generalized seizure while undergoing video monitoring. In total, there were seventy-seven recorded events amongst these patients. Of these, two patients (with five events) were excluded from a subsequent analysis because of recording inconsistencies (Table 1).

Overall, there were more patients who had epileptic events ($n = 59$) compared with those with nonepileptic events ($n = 13$). This difference reflects the working population of a video monitoring unit undertaking diagnostic evaluations of seizures and pre-epilepsy surgery evaluation.

Patients with PNESs had a higher median respiratory rate immediately postictally than those with GTCSs. This difference was significant, with the median respiratory rate of patients with PNESs at 26.8 breaths/min and the median respiratory rate of patients with GTCSs at 22 breaths/min ($p = 0.047$) (Table 2 and Graph 1). There then followed a trend of more rapid normalization of respiratory rate for those with PNESs compared with those with GTCSs.

Immediately postictally, the patients with PNESs tended to breathe faster than those with ESs. Two patients had respiratory rates greater than 45 breaths/min (see Graph 1). There was, however, a broad spread of data points of both patients with PNESs and patients with ESs immediately postseizure. The respiratory pattern of patients with PNESs returned to normal significantly quicker than that of patients with GTCSs. The time it took for this normalization to happen was 3.28 min for the group with PNESs and 6.34 min for the group with GTCSs ($p < 0.0001$) (Table 3). There was a moderate degree of interobserver agreement on the normalization of patient respiratory pattern (kappa 0.57).

No patients with PNESs exhibited obstructed breathing during the postictal phase. Conversely, thirty-five of the fifty-nine (65%) patients with ESs had stertorous postictal breathing. There was a high degree of interobserver agreement on the presence of stertorous breathing (kappa 0.66). The absence of snoring was highly sensitive (100%) but only moderately specific (59.3%) for predicting a nonepileptic event.

While reviewing the videotapes, it became apparent that adequate visualization of the patient at the appointed time periods was not always possible. This was a technical limitation of this study.

4. Discussion

Azar et al. have shown that the postictal respiratory pattern can help differentiate epileptic seizures from PNESs with generalized motor activity. However, in that study, the reader was not blinded to the seizure itself. It is acknowledged that some seizure manifestations are suggestive of nonepileptic seizures and could act as a potential source of bias [11].

We, therefore, wanted to review the postictal breathing rate and respiratory pattern while being blinded to the nature of the seizure itself. The model we used had some limitations. As the camera is fixed, personnel walking in front of the camera can obscure vision, and if the patient is under bed clothes, then the camera resolution may be insufficient to count the respiratory rate.

While failing to reach statistical significance at every two-minute interval, there is a significant difference in the respiratory rates between the two groups immediately postictally. There then follows a trend of those having had nonepileptic events returning to a normal respiratory rate sooner than those with epileptic seizures. There is an overlap in the recorded respiratory rates between the two groups, meaning that a respiratory rate recording alone is not diagnostic of PNES or ES.

Those who have had epileptic events are more likely to 'snore' postseizure and are more likely to have an abnormal respiratory pattern for a longer time period. The presence of snoring reflects a patient with impaired consciousness breathing against a partially obstructed airway. Sen et al. previously showed that stertorous breathing postictally was more typical following epileptic convulsions than after psychogenic nonepileptic seizures. We replicated this finding and also identified a

Table 2
Median postictal respiratory rate.

Group	PNES 0 min	ES 0 min	PNES 2 min	ES 2 min	PNES 4 min	ES 4 min	PNES 6 min	ES 6 min	PNES 8 min	ES 8 min
Median RR	26.8	22.0	18.2	21.1	19.6	19.9	16.7	19.8	18.00	19.7
SD	13.22	4.9	2.5	4.8	6.6	4.2	4.2	3.5	0.00	3.4
SEM	4.2	0.7	0.78	0.67	2.5	0.57	2.40	0.53	0.00	0.58
N	10	53	10	51	7	54	3	44	3	35
The two-tailed p-value		**0.047**		**0.066**		**0.884**		**0.150**		**0.405**

PNES (psychogenic nonepileptic seizure), ES (epileptic seizure).