

Electrocardiography in epilepsy patients without cardiac symptoms*

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Sudden unexpected death in epilepsy (SUDEP) has been ascribed to cardiac arrhythmia, possibly triggered by cerebral events. Young, noncompliant, substance-abusing males with convulsions may be at risk. EEG/ECG studies have not shown significant cardiac arrhythmias in these and other seizure patients. We reviewed resting ECGs in 75 epilepsy patients and compared ventricular rate, PR interval, QRS duration, and QT interval corrected for heart rate (QTC) with normal ECGs recorded in age-matched patients without cardiac or neurologic disorders. No potentially lethal arrhythmias were noted in the seizure patients. Patients who fit the previously-described profile of high risk of SUDEP had more abnormal ECGs and ventricular rate was faster in these patients than in other epileptics. Patients with complex partial and secondarily generalized seizures had faster ventricular rates than other epileptics. No differences were noted in QRS duration or PR interval. QT was longer in patients with complex partial seizures than in control ECGs or other epileptic patients.

These findings suggest that resting ECG has low diagnostic yield in epilepsy patients without cardiac symptoms. The factors possibly predisposing to SUDEP may relatively increase resting heart rate, however, and relatively increased QT interval with complex partial seizures may indicate some differences, possibly neurally-mediated, in cardiac excitability which could contribute to SUDEP.

Key words: epilepsy; seizures; electrocardiogram; arrhythmia; sudden death.

INTRODUCTION

Sudden unexpected death in epilepsy (SUDEP) is an important problem in the management of seizure patients^{1–3}. Cardiac changes have been shown to develop in epilepsy and status epilepticus^{4,5} and neurogenic pulmonary oedema, acute heart failure and cerebrally-mediated cardiac dysrhythmia have been suggested as causes of SUDEP^{6–8}. Some studies indicate little or no electrocardiographic (ECG) abnormality in seizure patients⁹, while other studies^{10,11} have found ECG differences, particularly involving the QT interval which is a predicator of sudden death¹². We reviewed ECGs in 75 epilepsy patients, and compared them to normal ECGs recorded in age-matched patients without cardiac or neurologic disorders.

SUBJECTS AND METHODS

Seventy-five patients had 12-lead ECGs on admission to the Epilepsy Unit at Ohio State University Hospital, and were subsequently found to have partial or generalized seizures and begun on appropriate antiepileptic drug regimens with no subsequent complications. They ranged in age from 20 to 64 years and had no other illnesses, particularly cardiovascular problems. Fifty-one were male and 24 female. Fifty had complex partial seizures, 15 suffered partial and secondarily generalized seizures and 10 experienced generalized seizures. Fifty of the patients, 35 male and 15 female, had a history of head injury, medication noncompliance, mental illness, or alcohol or substance abuse, factors which have been said to predispose to SUDEP^{2,11}. The ECGs of the patients were compared to retrieved normal ECGs in patients matched for decade of age with respect to ventricular rate, PR interval, QRS duration and QT interval corrected for heart rate (QTC).

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RESULTS

ECGs in normal and seizure patients are compared in Table 1. No significant cardiac dysrhythmias were noted in the seizure patients' ECGs. Ventricular rate was faster in seizure patients than in controls ($P < 0.01$), and the QTC was longer in those with epilepsy than in controls ($P < 0.05$). These were not outside the normal range, however. No significant differences were found in the PR interval or QRS duration. Complex partial and secondarily generalized seizure patients had faster ventricular rates than patients with generalized epilepsy ($P < 0.01$). PR interval was shorter and QRS duration less in the former group, but not significantly so. QTC was longer in patients with partial and secondarily generalized seizures than in individuals with generalized epilepsy ($P < 0.01$).

DISCUSSION

These findings suggest that, while cardiac dysrhythmia may be rare and the resting ECG generally normal, ECG differences may exist between people with epilepsy and normals and between complex partial and secondarily generalized seizure patients and those with generalized epilepsy. Resting ECGs may be of little value in the assessment of seizure patients, but these differences may be relevant to the pathogenesis of SUDEP.

Our seizure patients had higher heart rates than controls, and patients with complex partial epilepsy or partial seizures with secondary generalization had faster ventricular rates than other seizure patients. This may reflect a lower level of physical fitness among seizure patients, or may be due to smoking, use of alcohol or drugs, or anxiety effects of interictal behavioural changes in seizure patients. Antiepileptic drugs may have cardiotonic effects, but our patients were off medication; the effects of other medications taken concomitantly cannot be excluded. The normal controls may also have been inadvertently selected for cardiovascular fitness. Faster heart rates among patients with epilepsy may nevertheless predispose to cardiac dysrhythmias.

We found no difference in PR interval or QRS duration between seizure patients and controls, or between patient groups. This and the paucity of rhythm disturbances in the rest-

Table 1: Comparison of ECG in seizure patients and normals

Ventricular rate (beats/min)			
Normals	65.3 ± 31.2		
Epilepsy patients	91.0 ± 40.9	$P < 0.01$	
Complex partial seizure ± secondary generalization	92.5 ± 38.8	$P < 0.01$	
Generalized seizures	62.8 ± 8.0		
PR interval (ms)			
Normals	155.2 ± 21.7		
Epilepsy patients	160.9 ± 40.2	NS	
Complex partial seizure ± secondary generalization	155.7 ± 21.2	NS	
Generalized seizures	160.6 ± 52.7		
QRS duration (ms)			
Normals	88.3 ± 13.7		
Epilepsy patients	85.4 ± 29.1	NS	
Complex partial seizures ± secondary generalization	84.8 ± 14.7	NS	
Generalized seizures	90.1 ± 29.4		
QTC Intervals (ms)			
Normals	404.6 ± 200.9		
Epilepsy patients	413.5 ± 155.6	$P < 0.05$	
Complex partial seizures ± secondary generalization	417.4 ± 155.9	$P < 0.05$	
Generalized seizures	406.8 ± 224.9		

ing ECGs is in accordance with the findings of Keilson *et al.*⁹ that ECG abnormality is uncommon in seizure patients. Differences of QTC agree with our earlier findings that QT interval may be relatively prolonged in people with epilepsy¹⁰. It also accords with the observation of Earnest *et al.*¹¹, who found QTC prolongation in patients with clinical features associated with SUDEP. Since prolonged QTC may predict sudden cardiac death¹², this suggests that cerebral influences or medical factors associated with epilepsy may prolong QT interval and predispose to cardiac dysrhythmia, particularly in association with seizures.

It is not clear why partial epilepsy should have a greater effect on QTC than generalized epilepsy. This could reflect an older partial epilepsy population, with subclinical cardiovascular effects of chronic epilepsy. Adult patients with partial epilepsy may also have a higher incidence of cardiovascular risk factors than younger generalized seizure patients.

It is possible that chronic temporal lobe epilepsy may exert long-term effects on the heart through effects on hypothalamic and brain stem centres, which may gradually prolong QT intervals and could lead to sudden cardiac events during seizures. This question may be settled by prospective cardiac studies in newly diagnosed seizure patients. These findings also suggest an aggressive approach to physical fitness and cardiac risk factors in epilepsy patients.

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REFERENCES

1. Terrence, C.F., Wisotsky, H.M. and Perper, J.A. Unexpected unexplained death in epilepsy patients. *Neurology* 1975; **24**: 594–598.
2. Leestma, J.E., Kalkelkar, M.B., Teas, S.S. *et al.* Sudden unexpected death associated with seizures: analysis of 66 cases. *Epilepsia* 1984; **25**: 84–85.
3. Leestma, J.E., Walczak, T., Hughes, J.R. *et al.* A prospective study on sudden unexpected death in epilepsy. *Annals of Neurology* 1989; **26**: 195–203.
4. Simon, R.P., Aminoff, M.J. and Benowitz, N.L. Changes in plasma catecholamines after tonic clonic seizures. *Neurology* 1984; **34**: 225–257.
5. Johnson, R.H., Lanbie, T.G. and Spaulding, J.N.K. Neurocardiology. In *Neurogenic Abnormalities of the Heart. Major Problems in Neurology*, Vol. 13. (Ed. J. Walton). Philadelphia, W.B. Saunders, 1984.
6. Terrance, C.F., Rao, G.R. and Perper, J.A. Neurogenic pulmonary edema in unexpected unexplained death of epileptic patients. *Annals of Neurology* 1981; **9**: 458–464.
7. Lathers, C.M., Schraeder, P.L. and Weiner, F.L. Synchronization of cardiac autonomic neural discharge with epileptogenic activity: the lock step phenomenon. *EEG and Clinical Neurophysiology* 1989; **67**: 247–259.
8. Lathers, C.M. and Shraeder, P.L. Review of autonomic dysfunction, cardiac arrhythmias and epileptogenic activity. *Journal of Clinical Pharmacology* 1987; **27**: 346–356.
9. Keilson, M.J., Hauser, A., Magrill, J.R. and Goldman, M.G. ECG abnormalities in patients with epilepsy. *Neurology* 1987; **37**: 1624–1626.
10. Denio, L.S., Drake, M.E., Pakalnis, A. and Phillips, B.B. Seizure type and QT interval: possible relevance to sudden unexplained death. *Epilepsia* 1989; **30** (Suppl. 3): 216.
11. Earnest, N.P., Cohen, J.A., Hossack, K.R. and Woods, J.P. Cardiac QT interval is prolonged in patients with clinical features associated with sudden death. *Neurology* 1990; **40** (Suppl. 1): 298.
12. Gospe, S.M. *The Significance of the ECG QT Interval in Electroencephalography*. Quincy, MA, Grass Instrument Co., 1991.