

Abnormal ECG, Seizures, and Associated Neurological Deficits

ECG CHALLENGE

James A. Reiffel, MD

In the early 1980s, a 17-year-old girl and her mother were referred to me. The mother had a life-long history of seizures—ultimately well controlled with phenytoin—but she had never had an ECG. Her daughter began to have seizures in late childhood, several times per year, 1 of which was particularly prolonged and left her with a new, permanent neurological disorder impairing motor skills, comprehension, and memory. Two years before the referral, the daughter had an ECG, after which her seizure medications were changed to phenytoin. The ECG is shown in Figure 1. What abnormalities are present and how, if at all, might they relate to the seizures? Would you continue to treat her with phenytoin, or would you change to another agent, and if so, which?

Please turn the page to read the diagnosis.

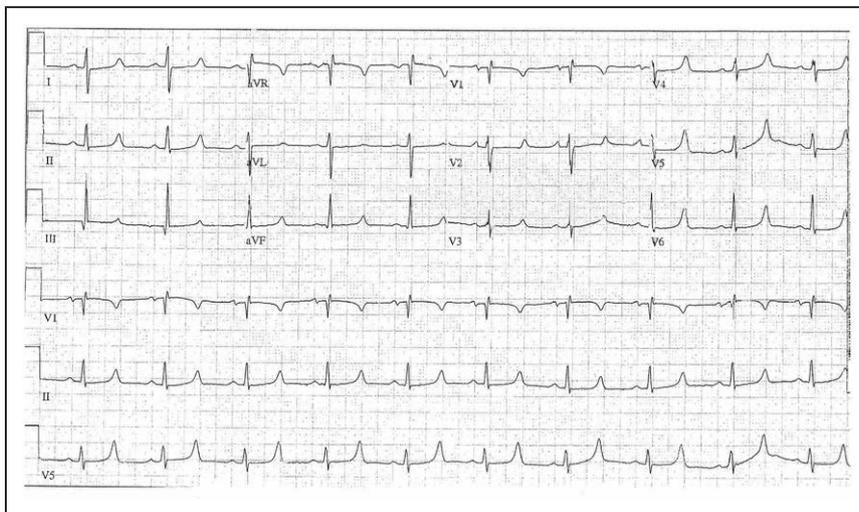


Figure 1. ECG of the Daughter at 15 Years of Age.

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RESPONSE TO ECG CHALLENGE

The ECG in Figure 1 reveals sinus bradycardia at 58 bpm, a PR interval of 200 ms, a QRS interval of 95 ms (with a slightly rightward axis), and a QT interval of 535 ms (QTc 534 ms). The latter notably demonstrates a marked delay of the T wave inscription (a long ST segment) with normal T wave width and only minor if any abnormalities in T wave morphology. This finding is characteristic of long QT syndrome type 3 in contrast to LQT types 1 and 2, where T wave width (eg, broad based in LQT1) and morphology are altered.^{1,2} Other laboratory studies were all normal. Specifically, hypocalcemia, the other entity that can produce a similar long ST segment ECG pattern, was not present. After this ECG, the possibility of seizures secondary to a ventricular tachyarrhythmia (torsades de pointes) was first considered. At that time, the mother had her first-ever ECG, which, on phenytoin, showed borderline long QT intervals. Neither daughter nor mother was genotyped (not clinically available at the time). Given that the patient's mother had done well on phenytoin, long QT3 results from abnormalities in sodium channel function,¹ and phenytoin is a class IB sodium channel blocker (with a long half-life), the choice of phenytoin to treat the daughter seemed reasonable. More recently, both mexiletine and ranolazine have shown to be effective in LQT3, although they have no role in the management of seizures from other etiologies.¹

Despite improvement in the daughter's seizure frequency and severity on phenytoin, because of the memory impairment and her mother's concern about the daughter's ability to comply with a medication regimen, additional therapies were used—specifically, a left stellate ganglion resection with cervical sympathectomy and atrial pacemaker implantation (lower rate of 80 bpm). Because dispersion of repolarization worsens steeply during bradycardia with LQT3, published reports suggest that pacing may be particularly helpful in this syndrome.³

The pacing shortened the QT interval by 40 milliseconds, which was only minimally changed by the surgical treatment, without other ECG changes. Phenytoin was continued. During the following decade, before the family moved and became lost to further follow-up, the daughter had no reported seizure recurrences.

It is impossible to tell whether this patient had true seizures versus convulsive syncope secondary to arrhythmias because cardiac monitoring was not done, although her response suggests the latter. The findings reported earlier suggest that at least in some patients, both seizures and neurological defects can be a consequence of long QT syndrome and its associated ventricular tachyarrhythmias with cerebral hypoperfusion/ischemic injury and not simply a comorbidity.⁴ Accordingly, in patients with unexplained or refractory seizures, and possibly in all patients with seizures, a 12-lead ECG should be part of the evaluation. Had a 12-lead ECG been done when this child had her first seizure early in life, her outcome, function, and quality of life likely could have been dramatically different.

DISCLOSURES

None.

AFFILIATION

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FOOTNOTES

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