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Intraoperative Epinephrine-induced Torsades de Pointes in a Child with Long QT Syndrome

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Torsades de pointes is a life-threatening ventricular tachyarrhythmia associated with QT interval prolongation. In the absence of an acquired etiology, QT prolongation is considered congenital. Patients with congenital long QT syndrome (LQTS) are at increased risk of experiencing torsades de pointes induced by catecholamines during the perioperative period. We present a case of intraoperative catecholamine-induced torsades de pointes leading to diagnosis of congenital LQTS and discuss the perioperative management of this syndrome.

CASE REPORT

An 11-yr-old otherwise healthy 33-kg girl with a history of urinary incontinence since birth was scheduled for cystoscopy and urethroplasty. She had had three prior uncomplicated urologic surgeries under general anesthesia at the ages of 3 months, 7 yr, and 10 yr. Her family history was notable only for a paternal grandfather with a history of transient ischemic attacks and a tachyarrhythmia responsive to propranolol. There was no history of recurrent syncope, sudden death, or deafness. Her parents and only brother were alive and well.

Anesthesia was induced with thiamylal and maintained with halothane and nitrous oxide in oxygen. Tracheal intubation was facilitated by pancuronium. A brief episode of ventricular bigeminy resolved after increasing anesthetic depth. Twenty milliliters of bupivacaine (0.25%) and epinephrine (1:200,000) were injected into the caudal epidural space. No tachycardia suggestive of an intravascular injection was noted. Forty minutes after caudal epidural injection, the surgeon injected 4 ml epinephrine (1:100,000) by infiltration for hemostasis. The patient promptly developed torsades de pointes (fig. 1). After 40 mg lidocaine was administered, the rhythm degenerated into coarse ventricular fibrillation. Defibrillation with 50 w-s converted the rhythm to ventricular bigeminy with a rate of 80 beats/min. This converted to normal sinus after 35 mg lidocaine was given. The procedure was stopped; emergence and tracheal extubation were unremarkable.

The patient was admitted to the pediatric intensive care unit for ECG monitoring and cardiac evaluation. Resting ECG revealed normal sinus rhythm, no evidence of preexcitation, a QT interval of 0.412 s, and corrected QT interval (QTc) (where $QTc = [QT \text{ interval}] / [\text{square root of RR interval}]$) of 0.480 s (fig. 2). Her echocardiogram was normal. Ambulatory ECG monitoring showed occasional unifocal premature ventricular contractions. With increasing heart rate during a

treadmill stress test, the QTc duration increased to 0.49 s. She had occasional unifocal premature ventricular contractions at higher stages of exercise. Resting ECG of her mother and father showed QTc values of 0.41 and 0.45 s, respectively. The diagnosis of LQTS was established. After β -blocker therapy was begun, her heart rate was 65 beats/min; her QT interval was 0.432 s; and her QTc interval was 0.446 s. Subsequent surgery was performed without incident during continuous caudal epidural anesthesia, intravenous sedation, and esmolol infusion.

DISCUSSION

Prolongation of the QT interval, whether acquired or congenital, is associated with electrocardiographic TU wave abnormalities and lethal dysrhythmias, namely torsades de pointes and ventricular fibrillation. However, differences exist between acquired and congenital QT prolongation with regard to clinical presentation, electrophysiologic characteristics, inciting triggers of ventricular tachyarrhythmia, and specific therapy.¹

Acquired QT interval prolongation is associated with class IA antidysrhythmic drugs (*i.e.*, lidocaine, disopyramide, and procainamide), phenothiazines, tricyclic antidepressants, organophosphates, pentamidine, trimethoprim-sulfamethoxazole, erythromycin, hypomagnesemia, hypokalemia, anorexia nervosa, liquid protein diet, third-degree atrioventricular block, and central nervous system insult.¹ In acquired (pause-dependent) LQTS, the first complex of torsades follows abrupt decelerations in ventricular rhythm and emerges from large postpause U waves. Prevention and treatment of torsades in these patients entail increasing the heart rate and eliminating pauses with catecholamines (isoproterenol) or pacing, and ultimately treating the underlying cause of QT prolongation.¹

Classically, the congenital LQTSs are classified according to inheritance pattern and presence of congenital neural deafness.² Congenital (adrenergic-dependent) LQTS is characterized by enhanced adrenergic responsiveness, in which naturally occurring or isoproterenol-induced tachycardia prolongs the QTU interval, augments U wave amplitude, and provokes torsades de pointes.¹ Evidence suggests that LQTS exists as a spectrum of disease.^{1,3,4} Atypical forms include symptomatic or asymptomatic individuals with a family history of LQTS who exhibit borderline or intermittently prolonged QT intervals or prominent U waves at rest. Presenting symptoms are syncope or sudden cardiac death associated with

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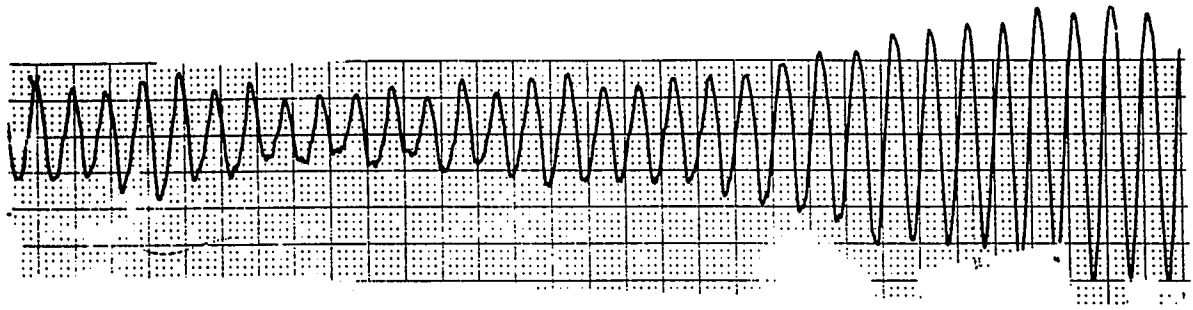


FIG. 1. Intraoperative ECG of torsades de pointes in the 11-yr-old girl in this case report.

high adrenergic states. Typically reported triggers of such symptoms include sudden exertion, pain, fear, intense emotions, startling noises, and delirium tremens.^{1,3} Provocative maneuvers that increase sympathetic activity (ECG exercise stress testing or ECG monitoring during exposure to an inciting stimulus) and ambulatory ECG monitoring help to establish the diagnosis and evaluate treatment efficacy.¹

Nearly all outcome studies examine mixed populations with regard to age but involve predominantly adults. Untreated mortality is estimated to be 73%.⁵ Moss *et al.* found mortality to be reduced with treatment, yet still high—1.3% per year.³ Risk factors for syncope or sudden cardiac death include congenital deafness, female sex, history of syncope, and previously documented torsades de pointes or ventricular fibrillation.³ It is noteworthy that the magnitude of QTc prolongation is not an independent predictor of risk.³ An abnormal echocardiographic ventricular contraction pattern appears to be associated with higher risk for syncope and cardiac arrest.⁶

No large studies have examined outcome in the pediatric population.⁷ If mortality were greatest in childhood, overall mortality rates could be much greater than previously described because of selection bias. In a retrospective study of 23 children with congenital LQTS,⁷ 19 (83%) were symptomatic, and 5 of these initially presented with sustained ventricular tachydysrhythmia requiring

resuscitation. There were 3 deaths in patients less than 9 years of age, despite appropriate medical therapy in 2 of them. Yet another untreated 13-yr-old had severe brain damage as a result of his second episode of ventricular fibrillation. Other reports also suggest that LQTS in childhood may be quite refractory to conventional treatment, and if so, adults with LQTS may represent a select group of least affected individuals.⁷

Long-term β -adrenergic blockade with propranolol is effective in 75–80% of congenital LQTS patients.¹ Moss *et al.* found the relative risk of syncope and cardiac death to be 0.41 with propranolol therapy.³ Overall mortality is reported to decrease from 73% to 6%.⁵ In the 20–25% of patients who continue to experience syncope or cardiac arrest despite β -blocker adrenergic therapy, left cervicothoracic sympathetic ganglionectomy appears very effective.⁸ Permanent cardiac pacing⁹ and the implantation of automatic defibrillators¹⁰ are options in patients with symptoms refractory to other therapy. Bretylium and guanethidine have had anecdotal success, whereas digoxin, calcium, and potassium have not. Phenytoin, primidone, and phenobarbital have shown limited success, while class I antidysrhythmic drugs have been reported to exacerbate congenital LQTS.¹

Moss *et al.* recommend that congenital LQTS patients with any of their four described risk factors should be maximally β -blocked.³ If symptomatic bradycardia de-

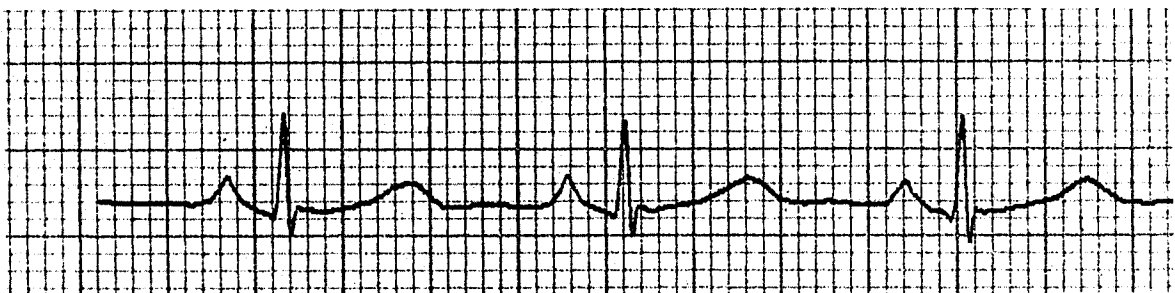


FIG. 2. The patient's resting ECG demonstrating a QTc interval of 0.480 s.

velops, pacemaker therapy should be instituted.⁹ Those with recurrent syncope refractory to β blockade should undergo left cervicothoracic sympathectomy or permanent pacing.⁹ As for LQTS individuals without risk factors, those with a family history of sudden death or syncope should be treated, while those without such family history should not.³

Recommendations for perioperative management of congenital LQTS patients have been variously described.¹¹ Adequate β -adrenergic blockade, adequate premedication, and avoidance of provoking increases in heart rate and catecholamine levels are important. The effects of anesthetic agents on QTc interval have been investigated. Succinylcholine,¹² thiopental,^{12,13} propofol,¹³ and isoflurane, enflurane, and halothane^{14,15} have been reported to prolong QTc in normal patients, while isoflurane has shortened QTc in LQTS patients.^{11,16} Thiopental has been reported to have no effect in congenital LQTS patients.¹⁶ In the presence of halothane, the myocardium may become sensitized to epinephrine, facilitating ventricular dysrhythmia.

We chose to prevent the heightened adrenergic tone associated with anxiety, pain, laryngoscopy, tracheal intubation, emergence, and extubation by combining a regional anesthetic with adequate sedation. Alternatives include avoidance of light anesthesia and extubation under deep anesthesia.¹¹ We achieved reliable heart rate control with an infusion of esmolol. We monitored QTc and transarterial pressure throughout. We were prepared to treat the acute onset of torsades de pointes; the treatment of choice in adults is rapid intravenous injection of 1–2 g magnesium sulfate,¹⁷ even in the face of normal total serum magnesium levels. A cardiac defibrillator and equipment for transvenous pacing were also in the room prior to induction.

LQTS should be considered in the differential diagnosis of any child or adult with a history of unexplained syncope or "seizures," especially if provoked by states of heightened adrenergic tone. As in this case, family members of congenital LQTS patients should be evaluated. Anesthetic management should be aimed at preventing increased catecholamine levels and their potentially lethal effects.

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