Dental Trauma After Cardiac Syncope in a Patient with Long QT Syndrome

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Abstract

Dental trauma secondary to a syncopal episode occurs rarely in the pediatric population. Although the majority of these events occurs in patients with a benign medical history, a subset of these cases occur in patients with a genetic predisposition to cardiac arrhythmia. Long QT syndrome, characterized by prolonged cardiac ventricular repolarization, represents one genetic condition in which patients sustain events of seizure, syncope, and sudden cardiac death in response to precipitating physical, mental, or emotional stressors. In this case report, extensive dental injuries occurred after an episode of cardiac syncope in a patient with a dual presentation of long QT syndrome and Pierre Robin sequence. The purpose of this paper was to highlight the potentially malignant course of symptomatic long QT syndrome and emphasize the importance of warning sign recognition and multidisciplinary medical management of pediatric patients with this condition. (Pediatr Dent 2006;28:547-552)

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Dental traumatic injuries occur with some regularity in the pediatric population. Studies have reported that as many as 20% of 13-year-old children have sustained some form of trauma to their permanent dentition.[1-3] Sports-related injuries, motor vehicle accidents, acts of violence and domestic abuse, and falls are common precipitating factors of trauma in children. Gassner and colleagues found that a child's susceptibility to dental trauma is age-dependent, with nearly a 5% decrease for each additional year of age.[4] There is, however, a subset of traumatic events that occurs suddenly after a child loses consciousness.

Syncope has been suggested to occur in 1 of every 800 pediatric patients seeking medical attention.[5] Syncope is defined as a loss of consciousness related to decreased cerebral perfusion and can be mediated by several mechanisms. Neurocardiogenic syncope—also known as vasovagal syncope—is the most common type occurring in the pediatric population with a predominance of these events occurring in adolescence.[5,6] Many of these episodes are precipitated by emotional stress in which autonomic stimulation results in a myriad of prodromal symptoms such as: (1) lightheadedness; (2) dizziness; (3) nausea; (4) pallor, (5) diaphoresis; and (6) visual changes. Neurocardiogenic syncope is normally found to be benign in nature. Conversely, cardiac syncope is a consequence of cardiac abnormalities in which obstruction to blood flow, myocardial dysfunction, and arrhythmias occur.[7] It is important to recognize that several of these cardiac conditions are due to congenital etiologies—including genetic mutations and, therefore, follow a familial distribution.

Long QT syndrome (LQTS) is a cardiac electrophysiological abnormality where the QT interval indicative of ventricular repolarization is prolonged on an electrocardiogram (ECG; Figure 1a and b) LQTS has been reported to occur through either autosomal inheritance or de novo mutation. Seven genes, LQT1 through 7, with more than 300 mutations are linked to dysfunction in cardiac myocellular ion currents leading to prolongation of ventricular repolarization.[8,9] Sustained delays in this process promote:

1. complex reentry circuits within the heart;
2. loss of a synchronized cardiac rhythm; and
3. a resultant polymorphic ventricular tachycardia known as torsades de pointes (TdP).

TdP can: (1) be self-limiting with return to baseline sinus rhythm; (2) persist as ventricular tachycardia; or (3) develop into ventricular fibrillation. These dysrhythmias compromise the oxygen supply to the brain and other vital organs, leading to episodes of: (1) syncope; (2) seizures; and (3) sudden cardiac death.

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LQTS occurs in 1 out of every 5,000 to 10,000 individuals in the general population, with an estimated prevalence of 30,000 to 60,000 cases in the United States. LQTS is primarily diagnosed in the pediatric population.[10] Suspicion of LQTS is heightened when:

1. unexplained syncope occurs;
2. syncope occurs during exercise in the pediatric population;
3. a family history of unexplained syncope is reported;
4. seizures occur;
5. congenital deafness is reported;
6. unexplained sudden death in individuals under the age of 40 years; and
7. heart-rate corrected QT interval prolongation (QTc interval greater than 440 milliseconds [ms] in males and 450 ms in females) is seen on the ECG.[11]

There are presently 4 main interventions:

1. beta blockers;
2. implantation of cardiac pacemakers;
3. use of implantable cardioverter defibrillators (ICD); and
4. left cardiac sympathetic denervation (LCSD), or combinations of the above, utilized in the prevention of the cardiac events for LQTS patients.[12,13]

The clinical success of these treatment modalities is related, in part, to the underlying genetic mutation.

The current clinical course for LQTS patients is highly variable. Treatment at this time is focused on the prevention of cardiac events, as the condition is not viewed as curative. Table 1 provides a list of Web sites that act as a source of information for families with LQTS and members of the medical profession.

The purpose of this paper was to:

1. focus on cardiac syncope as a precipitating factor of dental trauma in a child with long QT syndrome (LQTS) and Pierre Robin sequence; and
2. raise awareness on the recognition of warning signs such as syncope as a clinical marker of symptomatic LQTS.

Case report

A 7-year-old Caucasian male presented to the Emergency Department of the Strong Memorial Hospital at the University of Rochester Medical Center, Rochester, NY, with trauma secondary to a syncopal episode. He had a medical history significant for: (1) LQTS; (2) an implanted cardioverter defibrillator; (3) Pierre Robin sequence (PRS); and (4) attention deficit hyperactivity disorder (ADHD)

The patient had suffered extensive dental injuries, including the avulsion of 3 permanent maxillary incisors. The pediatric dental service was asked to:

1. confirm the complete avulsion of these teeth;
2. rule out the risk of aspiration for the remaining traumatized maxillary central incisor.

Clinical examination revealed injuries to the dentition only. The maxillary right central and lateral incisors and the maxillary left lateral incisor were avulsed intact and present bedside in a milk-filled container. The maxillary left central incisor sustained a lateral luxation injury. This tooth demonstrated 2 mm of mobility in the buccolingual dimension and depressibility into its alveolar socket. The tooth was assessed to be a moderate aspiration risk, although the patient's severe Class II malocclusion—resulting from PRS-associated mandibular micrognathism—prevented occlusal forces to be subjected to the tooth. Further dental intervention at that time was denied by the trauma team, as the child developed cardiac rhythms consistent with torsades de pointes. The child was later stabilized in the Emergency Department and subsequently admitted to the pediatric cardiac intensive care unit for further treatment and monitoring.

The pediatric dental team was unable to re-evaluate the patient during the first evening of his hospital course. The team was informed that the child was seen by

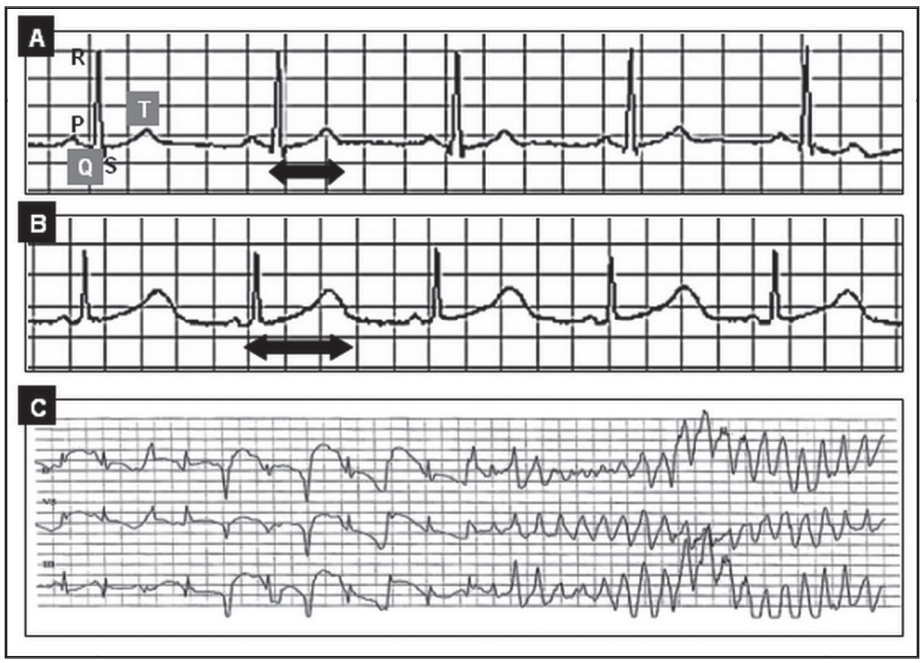

Figure 1a. Electrocardiographic tracings of a normal sinus rhythm.
Figure 1b. Prolongation of the QT interval. The QT interval indicative of ventricular repolarization is indicated by the black arrow. In plate B, the QT interval is markedly prolonged when compared with the normal sinus rhythm. The ECG tracing shown in plate C was recorded during the hospital course for this patient. The tracing (read from left to right) indicates degeneration of the sinus rhythm into one consistent with torsades de pointes tachyarrhythmia. This nonperfusing, shockable rhythm predisposes long QT syndrome patients to syncope, seizure, and sudden cardiac death. Plates A and B reproduced with permission.[31]

Table 1. Resources and Support Groups for Patients and Families With Long QT Syndrome*

Cardiac Arrhythmia Research and Education Foundation www.longqt.org
Sudden Arrhythmic Death Syndrome Foundation www.sads.org
To Spread the Word of Long QT Syndrome www.qtsyndrome.ch
Center for Education and Research on Therapeutics www.arizonacert.org
FAMILION genetic testing www.familion.com

*These Web sites also provide additional information on diagnosis and treatment that is of importance for the pediatric dental provider.

his primary care physician earlier in the day for a suspected otitis media infection. He sustained several discharges of his ICD throughout the day leading to an event of cardiac syncope in his garage.

In speaking with the child's family, the dental team learned that he was diagnosed with PRS through the classical presentation of: (1) cleft palate; (2) glossoptosis; and (3) mandibular micrognathism at birth. He subsequently underwent 3 cleft palate corrective surgeries, including 2 revisions of the initial correction under general anesthesia. During his third palatal procedure, the patient was found to have a prolonged QT interval through electrocardiographic monitoring. This observation suggested that the child may have LQTS. Referral to a pediatric cardiologist and subsequent testing by Holter electrocardiography confirmed the presence of LQTS. The child was immediately placed on ß-adrenergic antagonist medications, and, later that week, an ICD was placed while under general anesthesia.

Two years later, malfunction of the patient's ICD occurred, leading to multiple hospital admissions for bilateral pleural effusions and placement of a new ICD unit. Inominate vein collapse and subsequent stent placement heightened his risk for venous emboli. The patient was subsequently placed on warfarin therapy during the initial healing stages.

At the time of the dental traumatic event, the patient had just completed anticoagulant therapy, thereby complicating any potential surgical intervention by the dental team. Additionally, the patient was currently medicated with daily administration of 81 mg of aspirin, 25 mg of atenolol in the morning, 12.5 mg in the evening, and 10 mg of atomoxetine. Complete blood count and coagulation panels were performed by the treating physicians. The child was found to have an increased white blood cell count indicative of infection that was subsequently treated with intravenous antibiotics. His PT, PTT, and INR were all found to be within a normal range for surgical dental treatment.

Further dental examination of the patient was attempted on the second day of his hospital course. The child became agitated and intolerant of a tactile clinical examination and exposure of a maxillary occlusal radiograph. TdP arrhythmia occurred and necessitated emergency intervention (Figure 1c). Pediatric intensive care physicians refused further dental intervention without the use of intravenous (IV) sedation. The physicians recommended that the dental team examine the patient after his infection was controlled and cardiac stability was obtained.

On day 5 of his hospital course, the patient was sedated by his physicians with an IV bolus of midazolam and the dental team was able to obtain a partially diagnostic radiograph of the traumatized tooth. No overt root or alveolar fractures were noted. The mobility of the remaining incisor was found by digital palpation to be minimal and its depressibility was negligible. Aspiration risk was determined to be insignificant without additional trauma at this time. The dental team recommended extraction of the traumatized tooth as a means of preventing:

1. systemic infection originating from pulpal necrosis;
2. tooth aspiration resulting from additional cardiac events leading to dental trauma; and
3. complicated endodontic treatment planning, including multiple procedures under general anesthesia for a tooth with suboptimal prognosis.

The parents, although concerned with the psychological impact of losing additional permanent teeth, were understanding and agreed with the rationale of the surgical dental treatment plan.

The traumatized tooth was not extracted while in the pediatric intensive care unit. The risk of dental complications and inadequate airway management due to micrognathia and glossoptosis were found to be contraindications for extraction of the tooth under intravenous sedation. Additionally, the family reported that he had a complicated orotracheal intubation during a previous surgery as a consequence of his PRS-associated upper respiratory tract anatomy. Therefore, the managing physicians and pediatric dental team jointly agreed that the most appropriate setting for extraction of the traumatized tooth would be under general anesthesia in the hospital operating room with the presence of a pediatric anesthesiologist and the use of fiberoptic bronchoscopy.

The patient was subsequently discharged from the hospital after a 7-day admission with resolution of his infection and return to baseline pacing and function of his ICD. The dental team instructed the family to continue medicating him with oral amoxicillin prescribed by the intensive care physicians 4 times a day until the tooth extraction was completed. The child was scheduled for tooth removal under general anesthesia in 1 week.

The child returned 7 days later for dental surgery in the Strong Surgical Center at Strong Memorial Hospital, Rochester, NY. Upon arrival, the child was monitored preoperatively by electrocardiography. Physical assessment and verification of NPO status were performed by the managing pediatric anesthesiologist prior to premedication with 0.5 mg/kg oral midazolam. After informed consent was obtained for the dental procedures, the child was trans-

ported to the surgical suite. General anesthesia was achieved through mask induction with volatile sevoflurane anesthetic gas and maintained through the use of IV propofol anesthetic. In light of his venous system corrections, a loading dose of IV clindamycin at 20 mg/kg was given for subacute bacterial endocarditis prevention, per the recommendations of his cardiologist. Fiberoptic orotracheal intubation was completed by the attending pediatric anesthesiologist without complication. After his airway was stabilized and the patient was draped in the customary manner for a dental procedure, a maxillary anterior occlusal radiograph was exposed. An oropharyngeal throat pack was then placed. An alginate impression of the maxillary dentition and surrounding structures was obtained for future diagnostic purposes. The traumatized maxillary left central incisor was extracted in one piece without procedural complications. Gelfoam dental sponge (Pfizer Global Pharmaceuticals, New York, NY) was placed to encourage hemostasis and the extraction site was reapproximated with a single 4-0 chromic gut interrupted suture. After hemostasis was achieved, the throat pack was removed. The child tolerated the general anesthetic procedure well and was monitored by telemetry throughout his postoperative recovery period. The child was discharged to home after a short hospital asmission with traditional home care instructions for management of dental extractions.

Discussion

This article represents the initial documentation of a LQTS child in the pediatric dental literature and the second report of a dual presentation of LQTS and PRS in the medical literature.[14] As such, this case report attempts to raise awareness on the early warning signs and dental treatment considerations of LQTS patients as a means of preventing cardiac events in the dental office.

Identification of early warning signs through the acquisition of a comprehensive medical history and a review of systems is of paramount importance in the dental management of these patients. As a condition that is primarily symptomatic in individuals under 18 years of age, the responsibility for appropriate dental care of LQTS patients presumably falls mainly on the pediatric dentist. Pediatric dental providers must be aware of LQTS and other cardiac arrhythmias, as events of seizure or syncope can easily be misdiagnosed as more benign processes such as vasovagal syncope. Notably, syncope during physical exertion commonly indicates the presence of an undiagnosed cardiac abnormality necessitating medical attention.[7] As a general recommendation, patients who present to the pediatric dentist with a personal or family history of syncope should be referred to a pediatric cardiologist for electrocardiographic evaluation prior to any dental intervention. Conversely, patients who undergo a syncopal or sudden death event in the dental office should be referred to a hospital emergency department. Many patients with an original diagnosis of epilepsy have later been determined to sustain episodes of seizure as a result of LQTS-induced cerebral hypoperfusion. Therefore, the primary care physician or pediatric neurologist should confirm by ECG that the manifestations of epilepsy are not attributable to torsades de pointes arrhythmia.[15-18]

There are several medications used in dentistry for treatment of medical emergencies, emesis and behavior management, fungal and bacterial infections, and local anesthesia that have been shown to prolong ventricular repolarization. Chloral hydrate and epinephrine are 2 drugs that prolong the QT interval which are commonly used by pediatric dentists in the treatment of children. A comprehensive listing of medications known to prolong the QT interval—and which are considered to be contraindicated in patients with LQTS—are available on the Internet.[19] As a result, consultation with the patient's pediatric cardiologist should be undertaken prior to the delivery of any dental intervention.

Clinical dental guidelines for the appropriate care of LQTS patients have yet to be devised. To date, there is no evidence in the dental literature to support or refute the potential that patients with Long QT syndrome can be treated safely in the dental office. Interpretation of clinical recommendations provided by the various medical specialties can aid the pediatric dental provider in the clinical decision-making process. Anesthesiologists recommend that the monitoring of LQTS patients with electrocardiography should be continuous from the preoperative assessment through the procedure and recovery periods. These practitioners also utilize agents for premedication and sedation very commonly to reduce patient anxiety and stress in the preoperative period.[20] Pediatric dental providers lack the knowledge to effectively interpret electrocardiograms for QT interval prolongation and variability as well as the clinical capabilities to render operative treatment while conducting ECG monitoring. These dentists should probably treat these children in a setting where personnel with expertise in cardiac monitoring are present chair side.

The avoidance of physical, mental, and emotional stressors have been recommended by treating cardiac specialists for preventing events in daily life.[21] For example, LQTS individuals are instructed to avoid sports where physical contact or increased exertion (ie, basketball, swimming) may occur. Also, acute arousal stimuli should be minimized in the vicinity of these individuals.[22] Similarly, dental procedural stress and emotional triggers are known to cause instability in cardiac homeostasis in the general population and arrhythmia in adult patients with ischemic heart disease.[23,24,25] One can assume that these precipitating factors would place the LQTS patient at higher risk for cardiac events in the dental setting. Additionally, age-appropriate and anxiety-provoked behaviors in children can potentially encourage cardiac stress in the presence of dental procedures such as examinations, radiographs, and prophylaxes that are traditionally perceived to be noninvasive. It may, therefore, be prudent in light of the current lack of clinical evidence-

based epidemiologic data to treat these patients in a hospital setting where cardiac events can be managed expeditiously by trained personnel.

The administration of general anesthesia (GA) for LQTS patients commonly used for invasive procedures performed by medical professionals. LQTS children may require dental rehabilitation under GA as a result of:

1. their current medical status;
2. the inability to manage their stress and behavior; or
3. the extent and invasiveness of the dental interventions needed.

LQTS children who are indicated for dental procedures under GA should be evaluated by their treating specialists, including pediatric cardiologists and electrophysiologists, as part of their presurgical assessment. Many of the LQTS children have been reported to have various degrees of facial dysmorphia in addition to their cardiac condition.[26,27] As seen in the case presented here, anesthetic complications were avoided by the use of fiberoptic orotracheal intubation. It is, therefore, recommended that children with LQTS and associated craniofacial abnormalities undergo consultation with a pediatric anesthesiologist prior to the GA procedure.[28,29] A multidisciplinary approach to treatment under general anesthesia should be undertaken. Efforts should be made to coordinate diagnostic, preventive, restorative, and surgical dental interventions with medical procedures necessitating GA as means of reducing the number of GA experiences.

The treatment philosophy undertaken by pediatric dentists should be focused on the maintenance of oral health and prevention of unnecessary dental intervention. Diagnostic and preventive care should be conducted on a regular basis to maintain an up-to-date oral status for the child. Definitive restorative and surgical care should be undertaken as to minimize: (1) recurrent dental caries; (2) failed pulpal therapies; and (3) subsequent emergent care.

Dental trauma as seen in this report may be more appropriately managed by extraction vs endodontics and complex restorative care in some instances.[30] Replacement of traumatized or missing teeth should be performed on a case-by-case basis after thorough evaluation of the child's inherent risks and benefits. In the case presented here, tooth replacement has yet to be undertaken by either the pediatric dental team or the treating orthodontist, as the likelihood of recurrent dental injuries remains heightened in this child with PRS-associated Class II malocclusion. Additionally, the child's young age and his present early mixed dentition status make tooth replacement a less-than-ideal option from the perspective of orthognathic development and the need for continual adjustment of the tooth-borne appliance. Esthetics and speech maintenance should remain a consideration when agenesis, extraction, or traumatic loss of permanent maxillary incisors occurs. Speech dysfunction as a result of tooth loss in this case proved to be negligible in light of his pre-existing issues with maxillomandibular jaw discrepancy. A dental prosthesis for this child may be more likely to occur after combined orthodontic and orthognathic therapy with mandibular distraction osteogenesis occurs.

In conclusion, children with long QT syndrome should utilize the full capabilities of the pediatric specialist. Multidisciplinary approaches to medicine must take into account the social, emotional, psychological, and financial characteristics of the LQTS child and their family when making treatment decisions and recommendations. Informed consent must be obtained when designing a long-term treatment philosophy such as the one previously outlined. Age-appropriate LQTS children should maintain the ability to provide assent for treatment plans completed while under the legal age for consent. In the end, dental intervention plays a small yet important role in the overall health and well-being of LQTS children. Pediatric dental providers must recognize this fact and aim to provide dental care in an environment where cardiac events can be prevented and oral health can be maintained.

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Abstract of the Scientific Literature

Evaluation of Sealants in Teens Utilizing Air Abrasion

This prospective study compared sealants placed with acid etch and air abrasion with acid etch alone. Using a split mouth design, pit and fissure preparation was done on randomly assigned molars and premolars with acid etch on one side of the mouth (Group I); air abrasion followed by acid etch was done on the contralateral side (Group II). Sealants were placed on 162 teeth and evaluated for (1) complete retention, (2) partial loss or (3) total loss at 6, 12, and 24 months. At 6 months, the retention rates for the two techniques were not significantly different. Retention rates at 12 and 24 months were significantly higher for Group II. Molar retention rates were significantly less than premolar retention rates at each evaluation period. Sealant retention rates at 12 and 24 months were higher for Group II.

Comments: The results of this study, indicating a beneficial synergy of the combination of air abrasion and acid etch are in agreement with previous work using aluminum oxide as the air abrasive system. Stable long term bond strengths are possibly based in part on the increased surface area for bonding created by air abrasion. RKY

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Yazici AR, Kiremitçi A, Çelik Ç, Özgünaltay G, Dayangaç B. A two-year clinical evaluation of pit and fissure sealants placed with and without air abrasion pretreatment in teenagers. JADA 2006;137(10):1401-5

39 references