Seizures Due to Lidocaine Toxicity in a Child During Cardiac Catheterization

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SUMMARY. A 17-month-old boy developed grand mal seizures secondary to lidocaine toxicity during balloon dilatation of a congenital pulmonary valve stenosis. Lidocaine at 38 mg/kg (nine times the recommended maximum dose of 4.5 mg/kg) was administered during a 90-min period in order to optimize local anesthesia. This resulted in toxic serum lidocaine levels (8.7 mg/L; therapeutic range, 1.5–5 mg/L) at the time of seizures. Caution should be exercised with local anesthetics during invasive cardiac catheterizations. Hypercarbia (which lowers the seizure threshold to local anesthetics) should be avoided and the temptation to exceed the maximum recommended dose resisted.

KEY WORDS: Lidocaine — Toxicity — Cardiac catheterization — Seizures — Child

Palmisano et al. reported extreme lethargy associated with toxic levels of lidocaine in two of 10 children undergoing cardiac catheterization [12]. Seizure activity, a well-recognized manifestation of lidocaine toxicity [8, 10, 13], was not observed in these children. We recently observed toxic lidocaine levels in a child who had three grand mal seizures during a cardiac catheterization.

Case Report

A 17-month-old boy, weighing 10 kg, with known valvular pulmonary stenosis underwent cardiac catheterization and balloon dilatation of the pulmonary valve. He was premedicated with 0.9 ml Pre-cath mixture, which contained chlorpromazine (6.25 mg/ml), promethazine (6.25 mg/ml), and meperidine (25 mg/ml). Each groin was infiltrated with 30 mg of 2% lidocaine (without epinephrine). The syringe containing the local anesthetic was aspirated each time prior to injection to prevent intravascular administration of the drug. Percutaneous catheterization of the right femoral vein and left femoral artery was achieved without difficulty. Supplemental doses of lidocaine were administered during the procedure, when interventions elicited signs of pain from the child, resulting in a total cumulative dose of 380 mg lidocaine (38 mg/kg), given during the first 90 min of the procedure. This is approximately nine times the current recommended maximum dose for the subcutaneous infiltration of lidocaine (4.5 mg/kg of lidocaine without epinephrine) [7].

Forty-five minutes after the last dose of lidocaine, the child developed three grand mal seizures during a 3-min period, each seizure lasting approximately 30 s. The seizures ceased on the administration of 2 mg diazepam, intravenously. During the seizures the airway was controlled and 100% oxygen was delivered by a bag and mask device. Nevertheless, an arterial blood gas taken immediately after the seizures had stopped showed a respiratory acidosis (pCO₂ = 55 torr; pH = 7.19; PO₂ = 70 torr). One hour later a repeat blood gas showed a mild metabolic acidosis, although the arterial pCO₂ had returned to normal (pCO₂ = 43 torr; pH = 7.35; PO₂ = 183 torr). The lidocaine level, taken at the time of the seizure was elevated to 8.7 mg/L (therapeutic range, 1.5–5 mg/L).

There was no past or family history of convulsions. The child was not febrile or hypoxic throughout the catheterization (oxygen saturations > 95%). Serum electrolytes, osmolarity, and blood sugar were normal. Apart from initial postictal drowsiness, which may have been related to the seizures, diazepam, or lidocaine toxicity, the boy recovered completely without neurological sequelae or recurrence of seizures.

Discussion

Although seizures have been reported following inadvertent intravascular injection, overdosage, or rapid absorption of lidocaine in children [8, 10, 13], we are not aware of previous reports of lidocaine-induced seizures in children undergoing cardiac catheterization. Palmisano et al. [12] showed that
toxic levels of lidocaine (>5 mg/L) occur in children during cardiac catheterization. The present report illustrates that such levels can, in fact, lead to seizure activity.

Nevertheless, it is important to note that the actual lidocaine level is not the only factor in determining the toxic effects of lidocaine. The convulsive threshold for all local anesthetics is lowered in the presence of respiratory acidosis [4], which was documented in the child reported herein at the time of seizure activity. Hypercarbia lowers intra-neuronal pH and causes a shift in equilibrium from the unionized form of the molecule to the ionized form, which is the moiety associated with pharmacologic activity in the neuronal tissue [5]. Therefore, the treatment of lidocaine-induced seizures should be directed toward correcting hypoxia and hypercarbia, which are common in the actively convulsing child. Failure to correct respiratory acidosis may potentiate the convulsive state by increasing the ionized form of the drug, in addition to increasing cerebral blood flow and brain uptake of the drug [4]. Once a patent airway has been established, diazepam or one of the short-acting barbiturates, such as thiopental, remain the drugs of choice for controlling local anesthetic-induced seizures.

Neurological adverse reactions usually predominate in lidocaine toxic states [7]. However, cardiovascular adverse reactions occur which may be life-threatening. Sinus standstill and bradycardia have been reported in adults with high serum concentrations of lidocaine [1, 2]. Local anesthetics depress electrical and contractile activity in isolated hearts, but this effect is rarely seen in vivo [6]. Cardiac stimulation is the usual result from local anesthetic toxicity, primarily due to central nervous system stimulation.

Infants and toddlers appear to be at greatest risk for local anesthetic toxicity. They have a lower convulsive threshold indicated by the prevalence of febrile seizures in this age group. The mortality and morbidity from cardiac catheterizations per se are highest in early infancy, perhaps because older children undergoing catheterization are less sick [3]. Nevertheless, seven of 12 children, all weighing <15 kg undergoing cardiac catheterization, received doses of lidocaine greater than the maximum recommended dose (4.5 mg/kg), one child receiving a total dose of 47 mg/kg [12].

With the advent of invasive cardiology, often involving vascular access in more than one site, the temptation to infiltrate repeated doses of local anesthetics in order to optimize local anesthesia will exist, increasing the potential for toxicity. We suggest the following guidelines to help avoid such toxicity:

1. The maximum recommended dose of lidocaine (4.5 mg/kg) should be calculated for each child prior to the catheterization procedure. The physician should be informed when that dose has been given or is about to be exceeded. A decision to exceed this dose should be based on patient evaluation and the knowledge of the elimination half-life of lidocaine which can vary from 0.5–2 h in adults [6] and is more than 3 h in newborns [9].
2. Lidocaine at 1% (as opposed to 2%) is preferable in children, allowing a greater area to be infiltrated for a given dose of local anesthetic.
3. Intravascular injection of lidocaine can be prevented by intermittently checking for blood return while injecting.
4. Avoid infiltrating tissues beyond the immediate boundaries necessary to perform the procedure.
5. Avoid hypercarbia (most commonly due to excessive sedation) and metabolic acidosis, as these will reduce the convulsive threshold of local anesthetics.
6. When a child continues to be agitated following the maximum recommended dose of local anesthetic, consider causes of agitation other than pain, such as hypoxia, hypotension, and hypercarbia. The early symptoms of lidocaine toxicity (light-headedness, dizziness, and tinnitus) may also cause agitation.

The approach to preparing infants and children for invasive procedures should be viewed as involving more than just the induction of chemical sedation and local anesthesia. Much of the success of such procedures in pediatrics depend on controlling the expectations of the child by proper preparation, modifying the environment to maximize patient comfort, and appealing to the imagination of children to induce a trance-like state, in addition to the judicious use of sedation [11]. Finally, general anesthesia is an option that should always be considered for unstable patients and more complex procedures.

References