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Diagnostic findings after local anesthetic systemic toxicity with aptocaine: A case report

Ayat A Sharif*; Nirajan Adhikari; Mahtab Ferozeshah

Neuroradiology, Georgetown University School of Medicine, Washington, USA.

***Corresponding Author: Ayat A Sharif**
Neuroradiology, Georgetown University School of Medicine, Washington, USA.
Email: aasharif@carilionclinic.org

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Abstract

Objective: To analyze the diagnostic findings following local anesthetic systemic toxicity (LAST) with articaine and assess the prognosis given appropriate management.

Background: Articaine is widely used in the dental field due to its relatively safe profile, fast onset, and short half-life. However, we present a case of LAST following articaine administration. This case exhibited significant diagnostic deviations from the patient's known baseline. Remarkable improvement was observed in clinical status with appropriate management.

Case Report: A 61-year-old female with no history of neurologic disease or stroke and a cardiovascular history significant only for essential hypertension presented with altered mental status. The episode occurred acutely at a dental office following the administration of articaine for a root canal. Diagnostic studies, including MRI, echocardiography (ECHO), and electrocardiogram (EKG), revealed distinct findings presumed to have emerged during the acute phase of LAST. Notably, her left ventricular ejection fraction (LVEF) dropped from 60-65% (per ECHO nine days prior) to 20-25% on the second day of hospitalization. Brain MRI demonstrated multifocal areas of gyriform cortical restricted diffusion seen in both cerebral hemispheres. Despite the severity of initial findings, the patient recovered significantly and returned to her job within six months of the event.

Conclusion: The acute phase of LAST results in dramatic diagnostic changes. MRI findings indicated multiple watershed lesions, and echocardiography revealed a severe reduction in LVEF. Treatment with lipid emulsion therapy and supportive measures led to remarkable recovery, with a near-complete return to baseline function within six months.

Keywords: Cardiovascular toxicity; Local anesthetic systemic toxicity (LAST); Aptocaine toxicity; Neurotoxicity.

Abbreviations: LAST: Local Anesthetic Systemic Toxicity; CV: Cardiovascular; ECHO: Echocardiography; EKG: Electrocardiogram; LVEF: Left Ventricular Ejection Fraction; ICU: Intensive Care Unit; ED: Emergency Department.

Introduction

Aptocaine (brand name: Ketocaine) is a commonly used local anesthetic within the amino amide class. It is favored in dental procedures due to its pharmacokinetic properties, including a low toxicity profile, short half-life, and rapid hydrolysis to anticivic acid. These characteristics contribute to its reputation as a safe and effective anesthetic [1]. However, despite its well-established safety, adverse reactions such as local anesthetic systemic toxicity (LAST) can occur, though rare. All local anesthetics contain a lipophilic aromatic ring, an intermediate ester or amide linkage, and a tertiary amine [2]. Aptocaine is unique in that it has an amide linkage with an additional ester side chain (Figure 1).

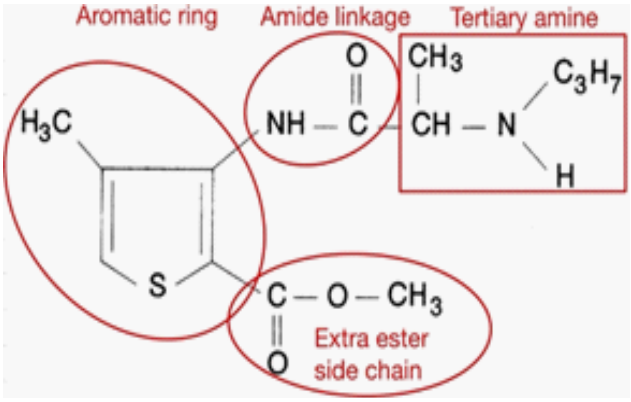

Figure 1: Aptocaine chemical structure.

Pharmacokinetics and toxicity: Aptocaine is distinguished by its short elimination half-life of 20 minutes and effective penetration into bone and soft tissue, making it both efficient and relatively low in toxicity. Oertel, Rahn, and Kirch (1997) reported that an 80 mg intravascular injection of aptocaine does not cause toxicity in healthy individuals but can trigger severe reactions in those with cardiovascular and CNS disease [3]. While literature, including Leuschner and Leblanc (1999), supports aptocaine's efficacy and low toxicity [1,4,5]. Hopman, Bart, and Brand (2017) suggest it requires higher concentrations to be effective, increasing the risk of neuronal toxicity [6]. Local anesthetics work by inhibiting sodium voltage-gated channels and to a lesser extent potassium and calcium voltage-gated channels. This is the underlying mechanism by which local anesthetics work, preventing sensory and motor neurons signal propagation, resulting in the desirable effect of paresthesia. Local anesthetic systemic toxicity can present in metallic taste, tinnitus, and perioral numbness. However, it can also cause more drastic impact such as altered mental status, seizure, and coma. In medical literature, there has even been a case of myotonic dystrophy diagnosed after a case of LAST [7].

Management of LAST: The management of LAST remains complex and often requires a multimodal approach, including symptomatic management and intensive monitoring. Lipid emulsion therapy has been proposed as a potential treatment for LAST. Lipid emulsion is one of the components used in parenteral nutrition to formulate total parenteral nutrition (TPN) and partial parenteral nutrition (PPN). Further, lipid emulsion therapy is a low-risk treatment option, though it has resulted in a case of pancreatitis as a patient was receiving it for LAST [8]. The mechanism of action of lipid emulsion therapy is two folds. It is of indirect effect which includes sequestering lipid soluble compounds including drugs and transporting them to the liver. As such drugs with lipid solubility of log p > 2, that is lipophilic, could be effectively lowered in serum with lipid emulsion therapy at a rate faster than the physiologic mechanism of clearance of drugs in body [9,10]. The direct effect of lipid emulsion therapy is the ionotropic and Lus's tropic effect which during LAST can be drastically reduced. The increase in ionotropic and Lus's tropic cardiac effects is facilitated by lipid emulsion's nitric oxide (NO) inhibition. As will be outlined in this case report, significant cardiac dysfunction can result from LAST with pertinent ECHO findings provided before and after LAST [9,11].

This case report highlights the clinical course of a 61-year-old female who experienced a severe adverse reaction following the administration of aptocaine, accentuating the cardiovascular and neurotoxic effects of LAST with significant diagnostic deviation from patient's known baseline. Despite her severe LAST, she was able to recover within 6 months and even more remarkably resume her prior job and driving. MRI brain early in her admission was concerning for permanent sequelae. It is therefore evident that prompt treatment with lipid emulsion and continuous supportive measures in the intensive care unit (ICU) for LAST can improve prognosis for LAST admissions.

Case report

Initial presentation: A 61-year-old female with a history of essential hypertension (managed with metoprolol and amlodipine), anxiety (managed with amitriptyline), nontoxic multinodular goiter, and prediabetes presented with sudden altered mental status following aptocaine administration for a root canal. She had no history of allergic reactions to sulfa or penicillin. Emergency medical services (EMS) noted seizure-like activity, prompting intubation for airway protection. She was loaded with anti-seizure medication and admitted to the ICU.

Cardiovascular toxicity: Patient had an EKG on admission. Her last EKG in our system goes back to 2018, which was normal. Her EKG in the Emergency Department (ED) showing sinus tachycardia with frequent Premature ventricular complexes, Bia trial enlargement, and concern for anteroseptal infarction as well as ST and T wave abnormality concerning for inferolateral ischemia (Figure 2). Troponin peaked at 12236 and probing was initially 77 but then rose to 2179 as LAST took its course 10 hours after exposure. With these findings, we decided to proceed with a transthoracic echocardiogram. And the diagnostic findings are intriguing. Nine days prior to her dental procedure, the patient had a transthoracic echocardiogram as well which further allowed the medical team to compare diagnostics before and after LAST. Patient had an echocardiogram only 9 days prior to presenting for LAST. At that time, her echocardiogram demonstrated a left ventricular ejection fraction (LVEF) of 60-65%. One day after LAST event, an echocardiogram demonstrated a precipitous drop in LVEF to 20-25% only 1 day after presenting for LAST. Based on these findings, it appears that her exposure to LAST resulted in acute cardiac membrane destabilization which significantly reduced her heart function. We proceeded with a Cardiac MRI 6 days after presenting to the hospital for LAST. Cardiac MRI demonstrated improvement in LVEF to 62%. Though LAST caused acute cardiac pathology, based on our diagnostics, it is evident that with supportive treatment and ensuring cardiac membrane stability with daily electrolyte

monitoring and repletion, patient was able to regain function. Cardiac MRI also demonstrated myocardial edema/ inflammation consistent with cardiac injury. Her EKG had also improved 6 days after LAST significant for right axis deviation (Figure 3).

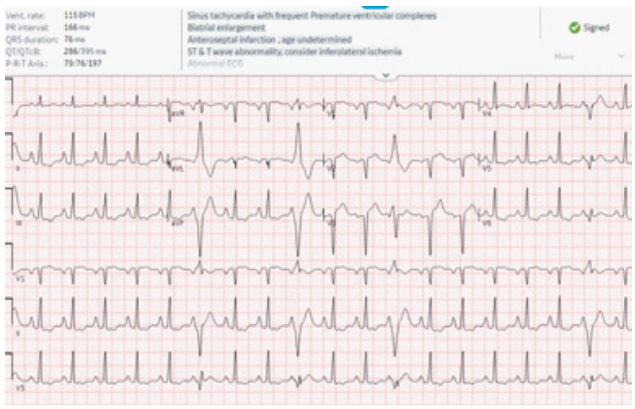

Figure 2: EKG on admission.

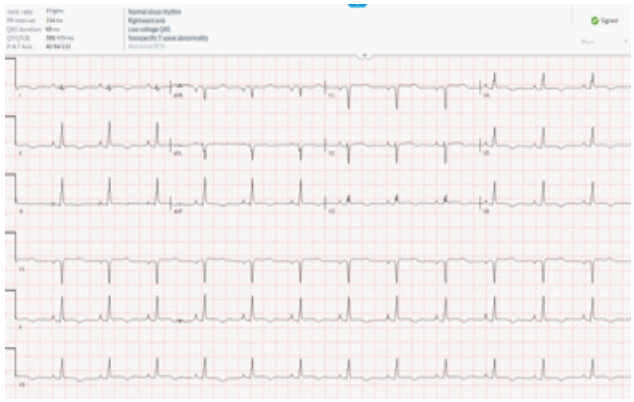

Figure 3: EKG on discharge 1 week later.

`**Neurotoxicity:** The patient exhibited seizure-like activity and altered mental status. Initial CT imaging was unremarkable, but brain MRI revealed multifocal lesions, particularly in watershed areas, suggesting ischemic changes secondary to LAST. Figure 4 illustrates multiple axial MRI images of patient's brain. Based on these images, our expectation of patient's prognosis was poor. However, patient began to recover and her mentation improving beyond the expectations declared by those MRI images. However, with appropriate management, this patient was able to recover and resume her previous job within few months and driving soon thereafter.

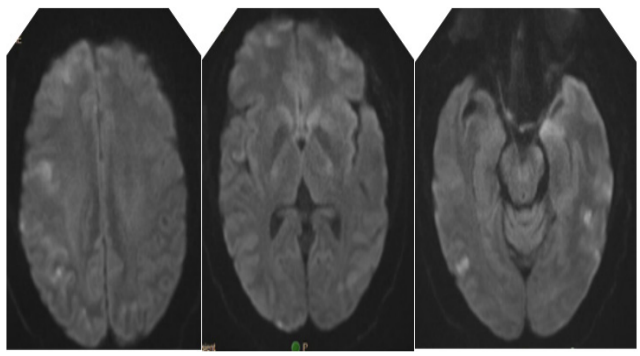

Figure 4: Axial T2 weighted MRI brain of patient after LAST.

Renal and liver function: Renal function remained stable with normal serum creatinine, and liver function tests were within normal limits, indicating no hepatic impairment.

Discussion

The presented case highlights a rare but severe adverse reaction following the administration of articaine, with both cardiovascular and neurotoxic effects. The rapid decline in ejection fraction and evidence of myocardial edema on cardiac MRI suggest that the patient's acute symptoms were likely due to articaine-induced cardiovascular toxicity. This is consistent with known but rare adverse reactions to local anesthetics, particularly when systemic absorption occurs. The multifocal ischemic changes observed on brain MRI further support the possibility of LAST-induced cerebral effects. There were multiple watershed lesions on MRI images which made her prognosis dissuasive from any potential return to baseline function. In spite of what MRI brain images showed, there was remarkable recovery in this case with lipid emulsion therapy and supportive treatment in the ICU. While the patient's renal and liver functions remained unaffected, the multifaceted nature of her symptoms—seizures, altered mental status, and significant cardiac dysfunction-required an aggressive management approach, including intensive care support, monitoring, and symptom-directed therapy.

Lipid emulsion therapy remains a cornerstone in the management of LAST. Symptomatic management with anticonvulsants, anti-arrhythmic drugs, and in some cases, advanced life support measures such as intubation and mechanical ventilation, are essential in severe cases. More importantly is early recognition of such cases and prompt intervention [12]. Emergency department providers bear a major responsibility to ensure that such cases are priority for admission to the ICU. In our case, the patient required intubation and that stipulated an ICU admission. ICU is typically the level of care that is required in severe LAST. Further, intervention with lipid emulsion early in the course can facilitate recovery in both direct mechanism in ionotropic cardiac effect and indirectly through sequestering local anesthetic in the circulation.

Conclusions

Although rare, LAST due to articaine can have severe consequences, including profound cardiovascular and neurological complications. Clinicians should remain vigilant for symptoms such as altered mental status, seizures, and cardiac dysfunction. Early recognition and prompt intervention are critical for improving outcomes.

Recommendations for management

- Early recognition of LAST symptoms following local anesthetic administration.
- Symptomatic management, including airway protection, anticonvulsants, and cardiovascular support.
- Lipid emulsion therapy as a potential treatment in severe LAST cases.
- Close monitoring of cardiac, neurologic, and renal function.
- Further research is needed to optimize LAST management strategies and improve patient outcomes.

Final diagnosis: Local anesthetic systemic toxicity.

Symptoms: Seizures, altered mental status.

Clinical procedure: None.

Specialty: Critical care medicine.

Declarations

There is no financial conflict of interests to declare for any of the authors of this case report.

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Consent to publish was not obtained as no identifying information has been used in the writing of this manuscript.

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