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Authors

Si Dung Chu [1, 2, 3]
MD, PhD in Cardiology, [1] Health Management Training Institute, Hanoi University of Public Health (HUPH); Pham Ngoc Thach General Hospital, HUPH, Vietnam Ministry Of Health; [2] Formerly Head of the Department of Emergency resuscitation and Poisoning Control, Hospital of Vietnam National University (VNU), Hanoi, Vietnam; Email: cds@huph.edu.vn, sichu.bvbachmai@gmail.com. Tel: +84 906086168. ORCID: 0000-0001-7723-5893

Nga Thuy Thi Nguyen [1]
[1] Health Management Training Institute, Hanoi University of Public Health (HUPH), Vietnam;

Ngoc Tuan Vo [1]
[1] Health Management Training Institute, Hanoi University of Public Health (HUPH), Vietnam;

Tuong Van Phan [1]
[1] Health Management Training Institute, Hanoi University of Public Health (HUPH), Vietnam;

Minh Thi Tran [3]
[3] Vietnam University of Traditional Medicine (VUTM), Vietnam;

Linh Tran Pham [4]
[4] Vietnam National Heart Institute, Bach Mai Hospital, Hanoi, Vietnam.

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Differential Diagnosis Between Local Anesthetic Allergy and Systemic Toxicity Following Septanest Administration in Endodontic Treatment: A Case Report

Abstract

Local anesthesia is a fundamental technique in modern dentistry, but acute adverse reactions present a significant diagnostic challenge. While serious amide local anesthetic allergies are exceedingly rare, distinguishing between an IgE-mediated immune response (anaphylaxis) and Local Anesthetic Systemic Toxicity (LAST) is critical, as their pathophysiological mechanisms and emergency management protocols differ entirely. This case report describes a 38-year-old female patient who developed extensive bilateral facial erythema and severe pruritus, rapidly progressing to the neck, just 5 minutes after a 1.8 mL infiltration of Septanest (4.0% Articaine with 1:100,000 Epinephrine) for endodontic treatment. The patient remained conscious without respiratory distress, and hemodynamic parameters were stable (Blood Pressure: 128/78 mmHg). Retrospective laboratory analysis revealed a markedly elevated total IgE level (1314 IU/mL), confirming an acute IgE-mediated type I hypersensitivity reaction. The patient responded optimally to immediate discontinuation of the dental procedure, followed by administration of an antihistamine (Diphenhydramine) and a corticosteroid (Methylprednisolone), with full resolution of symptoms within 1 hour and 15 minutes. This case underscores the paramount importance of immediate clinical differentiation of adverse local anesthetic events. The predominant cutaneous symptoms and stable hemodynamics supported a diagnosis of Type I allergy over LAST. The successful management reinforces the need for astute clinical reasoning, adequate preoperative assessment, and constant emergency preparedness in the dental operatory.

INTRODUCTION

Local anesthesia is an indispensable and foundational technique in modern dentistry, particularly for deep endodontic interventions such as root canal therapy, ensuring optimal pain control and patient comfort [1]. Among contemporary local anesthetics, Septanest – a formulation containing 4.0% Articaine combined with Epinephrine as a vasoconstrictor – is widely utilized due to its excellent tissue diffusion properties, rapid onset, and extended duration of action [1, 2]. Although serious adverse reactions to amide local anesthetics are exceedingly rare, with a reported incidence of less than 1%, the occurrence of acute post-injection complications always presents a formidable challenge to the clinical practitioner [1, 3]. One of the most common and potentially dangerous pitfalls in the dental setting is the clinical misdiagnosis and failure to differentiate between a localized or systemic IgE-mediated immune response (anaphylaxis) and the direct toxic effects resulting from excessive plasma concentration, known as Local Anesthetic Systemic Toxicity (LAST). These two conditions exhibit overlapping clinical features, yet their underlying pathophysiological mechanisms and established emergency management protocols are completely distinct [4]. This paper reports and analyzes a real-world clinical case to provide profound practical insights, assisting clinicians in optimizing the differential diagnostic process and acute management of local anesthetic complications in dental practice.

RESEARCH METHODOLOGY

This study employs a Case Report design combined with a comprehensive evidence-based retrospective literature review. Clinical and laboratory data, including detailed medical history, physical examination findings, electrocardiogram (ECG) monitoring, echocardiography results, and the progression of the emergency intervention, were collected directly from the medical records of a 38-year-old female patient. The differential diagnostic criteria utilized were based on current guidelines from the Vietnam Society of Anesthesiologists, the American Academy of Allergy, Asthma & Immunology (AAAAI), and updated international recommendations for the management of anaphylaxis and local anesthetic systemic toxicity [5, 6, 7].

CASE PRESENTATION

Demographics and History: A 38-year-old female patient presented for evaluation due to pain associated with deep dental caries, for which root canal therapy was indicated. The treatment plan proceeded with the administration of local anesthesia via infiltration of one cartridge (1.8 mL) of Septanest (4% Articaine with 1:100,000 Epinephrine). Five minutes post-injection, the patient developed extensive, scattered erythema over bilateral facial regions, accompanied by severe pruritus and rapid progression down to the neck. Notably, the patient did not report dyspnea, chest pain, or headache, and remained afebrile. The dental procedure was immediately terminated, and the patient was transferred to the Department of Emergency resuscitation and Poisoning Control at the Hospital of Vietnam National University (VNU) Hanoi in a conscious state, albeit communicating poorly due to extreme pruritus.

On Examination (Emergency Department):

Cutaneous Findings: Extensive macular erythema of varying sizes, scattered and rapidly progressing over the face and neck, with associated severe pruritus.

Vital Signs: Heart Rate: 68 beats/min (regular), Blood Pressure (BP): 128/78 mmHg, Respiratory Rate: 20 breaths/min, SpO2: 99.0% (on room air), Temperature: 36.9°C. Cardiac auscultation revealed regular rhythm with distinct S1 and S2 sounds.

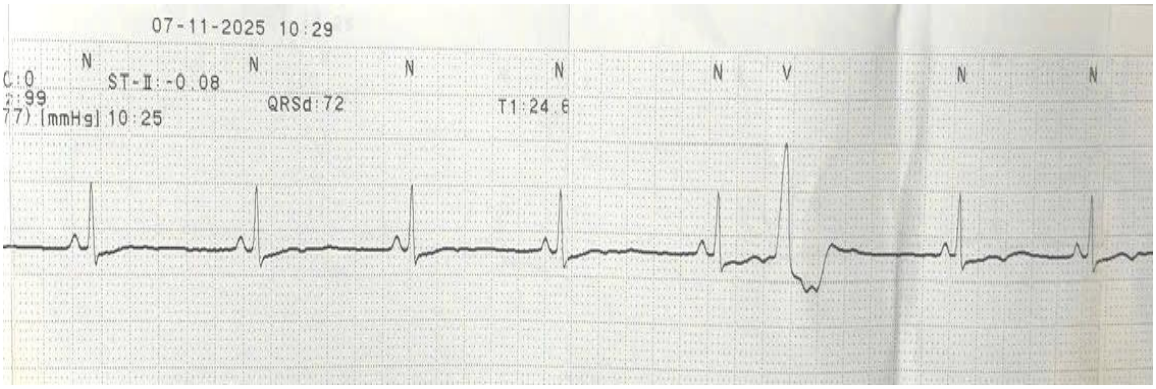

Figure 1 - ECG Monitoring: Occasional ventricular premature contractions (PVCs) were observed.

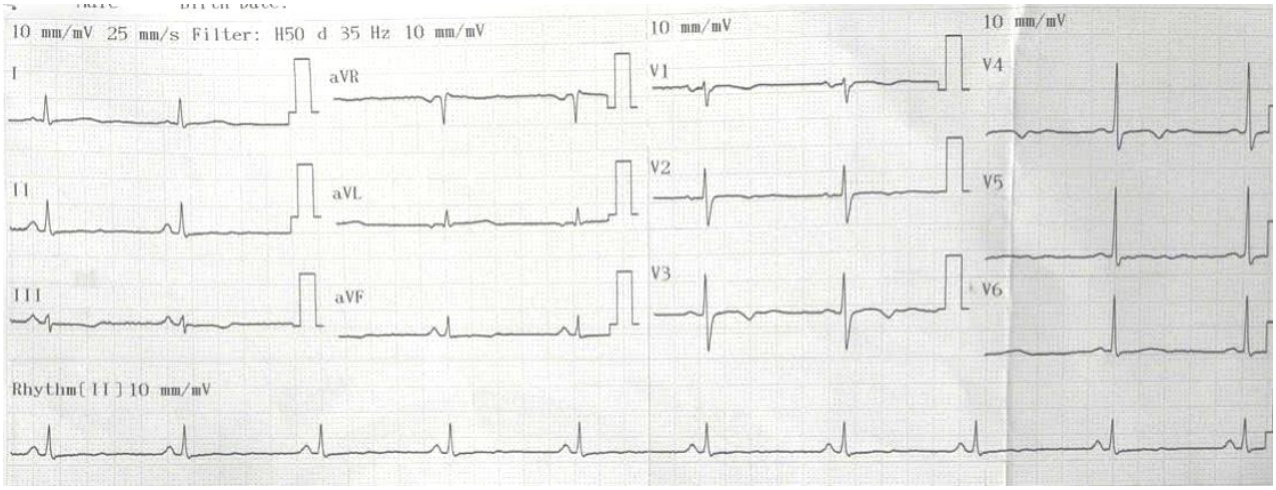

Figure 2 - ECG 12 Lead: The 12-lead ECG showed sinus rhythm at 60 beats/min with an indeterminate axis. Notably, ST-segment flattening was present in the inferior leads (DII, DIII, aVF), and T-wave inversion was noted in V2, V3, and V4.

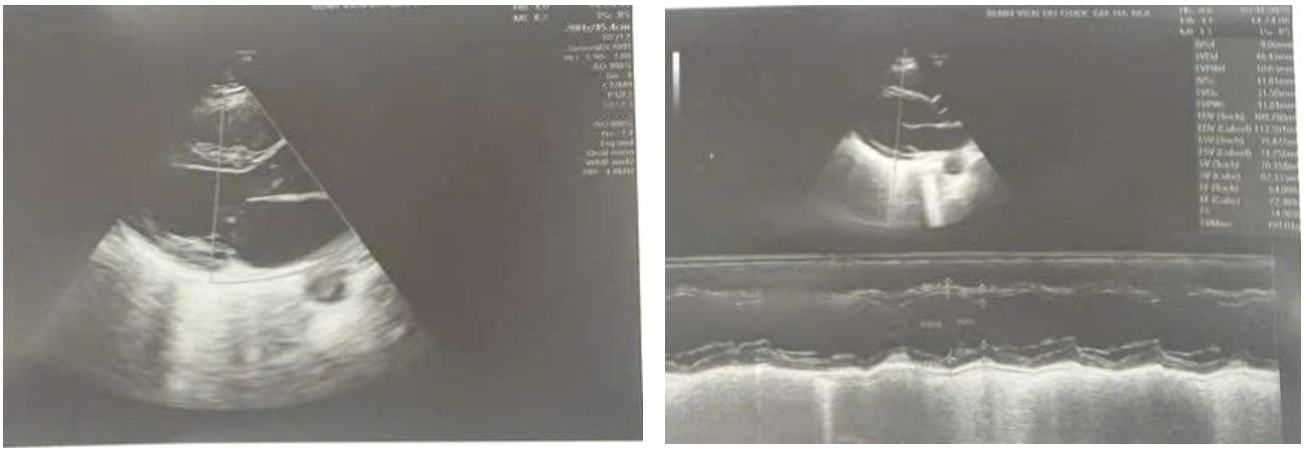

Figure 3 - Echocardiography: Occasional ventricular premature contractions were noted during the examination. There was evidence of mild mitral and aortic regurgitation. Left ventricular size and systolic function (Ejection Fraction: 64%) were within normal limits.

Laboratory Analysis:

Hematology: Red Blood Cells: 3.94 T/L; HGB: 121.1 g/L; White Blood Cells: 9.63 G/L; Platelets: 231.3 G/L.

Blood Chemistry: Creatinine: 69 umol/L (Ref: 44-100); Glucose: 6.68 mmol/L (Ref: 3.9-6.4 - slightly elevated); AST: 19.2 U/L; ALT: 14.0 U/L; Total Cholesterol: 3.89 mmol/L; Triglycerides: 1.38 mmol/L; HDL-C: 1.65 mmol/L; LDL-C: 1.61 mmol/L.

Inflammatory Markers & Cardiac Enzymes: CRP: 14.7 mg/L (Ref: 0-5 - elevated); CK: 190 U/L (Ref: 24-167 - slightly elevated); CK-MB: 19.7 U/L (Ref: < 24).

Electrolytes: Na+: 137.9 mmol/L; K+: 3.51 mmol/L; Cl-: 105.2 mmol/L; Total Calcium: 2.04 mmol/L (Ref: 2.15-2.6 - slightly low); Ionized Calcium: 1.05 mmol/L (Ref: 1.15-1.27 - slightly low).

Specific Immunology: Retrospective analysis of total serum IgE was markedly elevated at 1314 IU/mL (Ref: < 100).

Management and Course: The patient was diagnosed with a suspected moderate local anesthetic allergy (Type I Hypersensitivity Reaction/Anaphylaxis, based on the grading system of the Vietnam Society of Anesthesiologists, Ministry of Health) [5]. The management protocol was as follows: Bed rest in a 15-degree head-up position, with continuous monitoring of vital signs; Intravenous access established. Intravenous bolus of 500 mL normal saline (0.9% NaCl) given, followed by a separate IV infusion of 500 mL normal saline containing 20 mg of Diphenhydramine (Dimedrol), administered at a rate of 60 drops/min (LX gtt/min); and Intravenous administration of a corticosteroid (Methylprednisolone/Solumedrol) at anti-inflammatory/anti-allergic dosage.

Outcome: Within 1 hour and 15 minutes of initiating therapy, the extensive erythematous macules and severe pruritus over the face and neck began to resolve significantly. Hemodynamics remained stable with a heart rate of 60 beats/min, blood pressure of 110/64 mmHg, respiratory rate of 20 breaths/min, SpO2 of 99%, and temperature of 36.8°C. The patient was monitored in the inpatient setting for 24 hours. Vital signs and general condition remained completely stable without symptom recurrence, and the patient was discharged with instructions for outpatient follow-up.

DISCUSSION

The case presented serves as a distinct example of a true allergic reaction to local anesthesia occurring in a clinical setting. The retrospective immunological profile

was particularly revealing, with a 13-fold increase in the total serum IgE level (1314 IU/mL) over normal limits. This finding strongly supports the hypothesis of an acute IgE-mediated Type I (immediate) hypersensitivity reaction [8]. Mechanistically, upon re-exposure to components in the Septanest formulation, specific IgE antibodies bound to the surface of mast cells and basophils become cross-linked, triggering the massive release of preformed inflammatory mediators, including histamine. This release causes vasodilation (erythema and edema) and stimulates sensory nerve endings (severe pruritus) [1, 9]. The concomitant mild elevation in CRP (14.7 mg/L) also reflects an immediate inflammatory response [10].

The central issue that this case underscores is the imperative for an accurate differential diagnosis between Local Anesthetic Allergy (Anaphylaxis) and Local Anesthetic Systemic Toxicity (LAST):

Pathophysiological Mechanism: Allergic reactions are intrinsically tied to the immune system (either IgE-mediated or non-IgE-mediated). Conversely, LAST is a dose-related pharmacological phenomenon—a manifestation of direct toxic effects rather than a true allergy—occurring when excessive local anesthetic concentrations accumulate in the systemic circulation. Common causes include inadvertent intravascular injection, administration of a dosage exceeding the maximum recommended limit, or abnormally rapid absorption/impaired metabolism [4, 6].

Clinical Presentation: Allergic reactions typically manifest with prominent cutaneous signs (urticaria, angioedema, pruritus) and/or respiratory symptoms (bronchospasm, stridor, dyspnea). In stark contrast, LAST predominantly targets the central nervous system (circumoral numbness, metallic taste, dizziness, visual disturbances, slurred speech, generalized seizures) and the cardiovascular system (severe arrhythmias, profound myocardial depression, significant hypotension, or cardiovascular collapse) [4, 6]. In the present case, the initial and predominant symptoms were rapidly progressive erythema and severe pruritus, developing within 5 minutes. The crucial differentiating factor was the patient's neurological status: she remained conscious and communicable, with stable blood pressure (128/78 mmHg). This combination of predominant cutaneous symptoms and hemodynamic stability allowed the clinical team to confidently exclude LAST early in the assessment [6].

Specific Cardiovascular Manifestations: The observation of occasional PVCs on the monitor, along with the ST-segment flattening and T-wave inversion on the 12-lead ECG, warrants careful interpretation. These changes could potentially stem from a secondary sympathetic response to extreme patient stress and anxiety, or perhaps reflect a pharmacological side effect of the Epinephrine (vasoconstrictor) contained within the Septanest formulation, possibly in combination with the patient's slightly low ionized calcium level (1.05 mmol/L), which can increase myocardial irritability [11].

The distinction of Epinephrine-induced reactions is another critical differential to keep in mind, as it also presents with tachycardia, anxiety, and potential ECG changes [1]. The mild elevation in CK (190 U/L) suggested a minor degree of mechanical stress to the myocardium; however, since the CK-MB fraction was normal (< 24 U/L), acute myocardial necrosis (myocardial infarction) was ruled out [12].

From an epidemiological and pharmacological perspective, Septanest utilizes a modern amide local anesthetic, Articaine. Amide formulations generally do not contain preservatives from the paraben family (like methylparaben), which have a structural similarity to PABA and were responsible for the high allergy rates seen with ester local anesthetics. Consequently, true allergic reactions to modern amides are extremely rare (<1.0 %) [1, 2]. Nevertheless, hypersensitivity can still occur, either to the parent Articaine molecule itself or, more commonly, to other excipients. Retrospective studies have frequently implicated the antioxidant sodium metabisulfite (present in formulations containing epinephrine to prevent oxidation) as a culprit, particularly known to provoke bronchospasm in susceptible individuals [1, 13]. Importantly, there is a very low rate of cross-reactivity between different amide local anesthetics, which is a critical piece of information for planning future dental care for this patient [1]. The emergency management provided – Including IV fluids, Dimedrol, Solumedrol, and positioning the patient with the head elevated - is consistent with updated guidelines for Type I allergy [5]. While Adrenaline (Epinephrine) remains the first-line treatment for anaphylaxis, it was appropriately deferred in this case as there were no impending signs of respiratory or circulatory compromise [5].

RECOMMENDATIONS:

First, Thorough Medical History: Before administering local anesthesia for any dental procedure, practitioners must obtain a detailed medical history, specifically probing for any prior adverse reactions to local anesthetics, general drug allergies, food allergies, or any uncharacteristic experiences during previous dental visits.

Second, Meticulous Injection Technique: Practitioners should strictly adhere to safe injection practices, which include performing aspirating syringe techniques before and periodically during the injection. This is vital to ensure that the needle tip is not intravascular, thereby mitigating the risk of inadvertent systemic toxicity (LAST). The local anesthetic should always be injected slowly, with the clinician maintaining a high index of suspicion and constantly monitoring the patient's verbal and non-verbal cues for any subtle signs of an adverse event [4].

Third, Emergency Kit Preparedness: All dental practices must have an unexpired and complete emergency drug kit readily available, including Adrenaline (Epinephrine), which is the cornerstone for anaphylaxis management. Dental operatories must also be equipped and staffed to manage local anesthetic systemic toxicity (LAST), including access to international guidelines and necessary therapies such as intravenous lipid emulsion 20% (Intralipid), should a catastrophic event occur [4, 5].

Finally, Patient Education: Patients should be educated that should any late-onset adverse symptoms (such as

delayed urticaria or dyspnea) occur after leaving the dental office, they must not self-medicate with over-the-counter antihistamines and should immediately seek professional evaluation at an emergency medical facility.

CONCLUSION

True Type I allergy to local anesthetics is an exceptionally rare event in contemporary dental practice, especially with the use of modern, high-safety amide agents like Septanest (Articaine). However, this case report vividly demonstrates that such reactions are still possible. The immediate recognition of rapidly progressive clinical symptoms (cutaneous manifestation in this case) and, crucial to this discussion, the ability to immediately differentiate an allergic reaction from the far more prevalent local anesthetic systemic toxicity (LAST) or even epinephrine side effects, are absolutely paramount to successful acute management. The prompt discontinuation of the triggering procedure, establishment of IV access, and appropriate administration of an antihistamine and corticosteroid yielded an excellent patient outcome, preserving the patient's well-being and life. This case reinforces that astute clinical reasoning, thorough preoperative patient assessment, and constant emergency preparedness remain the pillars of patient safety when utilizing local anesthesia in the dental setting.

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