

Local Anesthetic Systemic Toxicity (LAST) Following Peripheral Nerve Block: A Case Series

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Abstract

Background

Local anesthetic systemic toxicity (LAST) is a rare but potentially life-threatening complication of regional anesthesia that may occur following peripheral nerve blocks due to inadvertent intravascular injection or rapid systemic absorption of local anesthetic agents. Although the incidence has decreased with the widespread use of ultrasound-guided techniques, LAST remains a critical perioperative emergency requiring immediate recognition and prompt management. This case series describes the clinical presentation, management, and outcomes of five patients who developed LAST following peripheral nerve block.

Case Series

Five patients undergoing orthopedic procedures under ultrasound-guided peripheral nerve blocks developed symptoms of local anesthetic systemic toxicity shortly after administration of local anesthetic agents. Clinical manifestations ranged from early neurological symptoms, including circumoral numbness, tinnitus, metallic taste, agitation, dizziness, and generalized seizures, to cardiovascular instability characterized by hypotension, bradycardia, and ventricular arrhythmias. Immediate recognition of toxicity, prompt airway stabilization, seizure control with benzodiazepines, cardiovascular support, and administration of 20% intravenous lipid emulsion therapy according to current American Society of Regional Anesthesia and Pain Medicine (ASRA) recommendations resulted in successful recovery in all patients. None of the patients experienced permanent neurological deficits, cardiac sequelae, or mortality.

Conclusion

Local anesthetic systemic toxicity remains an uncommon but serious complication of peripheral nerve blocks despite advances in regional anesthesia. Vigilant patient monitoring, meticulous injection techniques, appropriate dose calculation, and adherence to established preventive measures are essential to minimize its occurrence. Early diagnosis and prompt initiation of lipid emulsion therapy, together with comprehensive supportive management, are the key determinants of favorable clinical outcomes. This case series emphasizes the importance of maintaining preparedness for LAST wherever regional anesthesia is performed and reinforces the need for continued education and adherence to evidence-based management guidelines.

Keywords: Local anesthetic systemic toxicity; LAST; Peripheral nerve block; Regional anesthesia; Lipid emulsion therapy; Ultrasound-guided nerve block; Bupivacaine toxicity; Ropivacaine; Seizures; Case series

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Introduction

Local anesthetic systemic toxicity (LAST) is a rare but potentially life-threatening complication associated with the administration of local anesthetic agents during regional anesthesia. It occurs when toxic plasma concentrations of local anesthetics are reached following inadvertent intravascular injection, rapid systemic absorption, or administration of doses exceeding the patient's physiological tolerance. Although the incidence of LAST has declined with the increasing use of ultrasound-guided regional anesthesia and improved safety practices, it remains one of the most feared complications because of its potential to cause severe neurological and cardiovascular collapse.[1-4]

Peripheral nerve blocks have become an essential component of modern anesthetic practice owing to their ability to provide excellent intraoperative anesthesia, prolonged postoperative analgesia,

reduced opioid consumption, early mobilization, and enhanced recovery following surgery. Ultrasound guidance has significantly improved the precision and safety of these procedures by allowing direct visualization of nerves, surrounding structures, and needle placement. Nevertheless, local anesthetic systemic toxicity continues to occur despite adherence to recommended techniques, emphasizing that no regional anesthesia procedure is entirely risk free.[2,3,5]

The pathophysiology of LAST is primarily related to elevated plasma concentrations of local anesthetic agents that initially affect the central nervous system and subsequently the cardiovascular system. Early neurological manifestations include circumoral numbness, tinnitus, metallic taste, dizziness, agitation, confusion, and muscle twitching, which may rapidly progress to generalized seizures and loss of consciousness. As toxicity advances, myocardial sodium channel blockade produces conduction disturbances, ventricular arrhythmias,

severe hypotension, myocardial depression, and cardiovascular collapse. Bupivacaine is particularly associated with greater cardiotoxicity because of its high lipid solubility and prolonged binding to cardiac sodium channels.[1,2,4,6,7]

Several patient- and procedure-related factors increase the risk of developing LAST. These include inadvertent intravascular injection, administration of excessive doses of local anesthetics, injection into highly vascular regions, extremes of age, pregnancy, low body weight, hepatic dysfunction, cardiac disease, metabolic disorders, and reduced plasma protein binding. Although preventive strategies such as incremental injection, frequent aspiration, ultrasound guidance, and the use of lower effective doses have substantially reduced the incidence of LAST, complete prevention remains challenging.[3,8-10]

The diagnosis of LAST is primarily clinical and requires a high index of suspicion whenever neurological symptoms or cardiovascular instability develop during or shortly after administration of local anesthetic agents. Immediate discontinuation of local anesthetic injection, airway stabilization, seizure control, cardiovascular resuscitation, and prompt administration of intravenous lipid emulsion (ILE) therapy constitute the cornerstone of management. The American Society of Regional Anesthesia and Pain Medicine (ASRA) recommends early lipid emulsion therapy in patients with severe neurological or cardiovascular manifestations, as timely treatment has significantly improved survival and neurological outcomes.[2,6,11-13]

Despite advances in regional anesthesia and the availability of evidence-based management protocols, LAST remains an uncommon but serious perioperative emergency that requires prompt recognition and decisive intervention. Reporting individual cases and institutional experiences contributes to greater awareness among anesthesiologists, reinforces adherence to established treatment guidelines, and improves preparedness for this rare complication. We present a case series of five patients who developed local anesthetic systemic toxicity following peripheral nerve blocks, highlighting their clinical presentation, risk factors, management, and favorable outcomes achieved through early diagnosis and timely treatment.[10,12-15]

Case series

Case 1

A 56-year-old male (ASA II) weighing 72 kg was scheduled for open reduction and internal fixation of a fractured humerus under an ultrasound-guided supraclavicular brachial plexus block. After negative aspiration, 30 mL of 0.5% bupivacaine with 10 mL of 2% lignocaine with adrenaline was administered incrementally. Within two minutes of injection, the patient complained of circumoral

numbness, tinnitus, dizziness, and a metallic taste, followed by generalized tonic-clonic seizures. Oxygen was administered immediately, and intravenous midazolam (2 mg) terminated the seizure activity. Intravenous lipid emulsion (20%) therapy was initiated according to ASRA guidelines with a 1.5 mL/kg bolus followed by continuous infusion. The patient remained hemodynamically stable, recovered completely within 30 minutes, and surgery was postponed. He was discharged after 24 hours without neurological deficits.

Case 2

A 68-year-old female (ASA III) with hypertension and type 2 diabetes mellitus underwent ultrasound-guided femoral nerve block for total knee arthroplasty. Approximately three minutes after injection of 25 mL of 0.5% ropivacaine, she developed agitation, slurred speech, perioral numbness, and progressive confusion followed by profound hypotension (70/40 mmHg) and sinus bradycardia (40 beats/min). Local anesthetic systemic toxicity was immediately suspected. Oxygen supplementation, intravenous crystalloids, atropine, phenylephrine, and lipid emulsion therapy were administered promptly. Hemodynamic stability was restored within 15 minutes, and the patient recovered completely without cardiac arrhythmias. Surgery was rescheduled after full recovery.

Case 3

A 42-year-old male (ASA I) underwent ultrasound-guided interscalene brachial plexus block for arthroscopic shoulder surgery using 25 mL of 0.5% bupivacaine. Shortly after completion of the injection, he experienced tinnitus, blurred vision, restlessness, and generalized seizures followed by transient loss of consciousness. The airway was secured with endotracheal intubation, and mechanical ventilation was initiated. Intravenous midazolam controlled the seizures, while lipid emulsion therapy was started immediately. The patient remained hemodynamically stable throughout the event and was extubated uneventfully after two hours in the intensive care unit. Neurological examination remained normal, and he was discharged on the second postoperative day.

Case 4

A 61-year-old female (ASA II) underwent an ultrasound-guided popliteal sciatic nerve block for ankle fracture fixation using 30 mL of 0.5% levobupivacaine. Within five minutes of injection, she developed sudden dizziness, circumoral numbness, hypotension (80/50 mmHg), ventricular premature complexes, and progressive ventricular tachycardia. Cardiopulmonary resuscitation was not required as spontaneous circulation was maintained. Intravenous lipid emulsion therapy was initiated immediately along with oxygen, intravenous fluids, and amiodarone. The ventricular arrhythmia

resolved within several minutes, and the patient achieved complete cardiovascular recovery. She remained under intensive monitoring for 24 hours and was discharged without complications.

Case 5

A 50-year-old male (ASA II) was scheduled for distal radius fracture fixation under an ultrasound-guided axillary brachial plexus block using 30 mL of 0.5% bupivacaine. Approximately one minute after injection, he complained of circumoral numbness, tinnitus, anxiety, and chest discomfort, followed by hypotension (78/46 mmHg) and generalized tonic-clonic seizures. Immediate airway support with 100% oxygen, intravenous midazolam, rapid crystalloid infusion, vasopressor support, and intravenous 20% lipid emulsion therapy were administered according to established guidelines. The seizures ceased promptly, hemodynamic parameters normalized within 20 minutes, and no recurrent neurological or cardiovascular manifestations occurred. The patient recovered completely and was discharged after overnight observation without residual sequelae.

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5
Age/Sex	56/M	68/F	42/M	61/F	50/M
ASA Status	II	III	I	II	II
Surgical Procedure	ORIF Humerus	Total Knee Arthroplasty	Arthroscopic Shoulder Surgery	Ankle Fracture Fixation	Distal Radius Fracture Fixation
Peripheral Nerve Block	Suprascavicular Brachial Plexus Block	Femoral Nerve Block	Interscalene Brachial Plexus Block	Popliteal Sciatic Nerve Block	Axillary Brachial Plexus Block
Local Anesthetic Used	0.5% Bupivacaine + 2% Lidocaine with Adrenaline	0.5% Ropivacaine	0.5% Bupivacaine	0.5% Levobupivacaine	0.5% Bupivacaine

Time to Symptom Onset	2 min	3 min	2 min	5 min	1 min
Initial Clinical Features	Circumoral numbness, tinnitus, metallic taste	Perioral numbness, agitation, confusion	Tinnitus, blurred vision, restlessness	Dizziness, circumoral numbness	Circumoral numbness, tinnitus, anxiety
Major Manifestations	Generalized seizures	Hypotension, bradycardia	Generalized seizures with transient unconsciousness	Ventricular tachycardia, hypotension	Generalized seizures, hypotension
Management	Oxygen, Midazolam, 20% Lipid Emulsion	Oxygen, Fluids, Atropine, Phenylephrine, Lipid Emulsion	Intubation, Mechanical Ventilation, Midazolam, Lipid Emulsion	Oxygen, Fluids, Amiodarone, Lipid Emulsion	Oxygen, Midazolam, Vasopressors, Lipid Emulsion
ICU Admission	No	No	Yes	Yes	No
Outcome	Complete recovery	Complete recovery	Complete recovery	Complete recovery	Complete recovery
Residual Neurological/Cardiac Deficit	None	None	None	None	None

Discussion

Local anesthetic systemic toxicity (LAST) remains one of the most serious complications of regional

anesthesia despite significant advances in ultrasound-guided peripheral nerve block techniques. Although its reported incidence is low, LAST continues to pose a major challenge because of its potential to cause rapid neurological deterioration, life-threatening cardiac arrhythmias, and cardiovascular collapse. The widespread adoption of ultrasound guidance, incremental injection, and routine aspiration has reduced the frequency of inadvertent intravascular injection; however, these measures do not completely eliminate the risk of systemic toxicity.[1-4]

In the present case series, all five patients developed clinical manifestations of LAST within a few minutes following peripheral nerve block administration, which is consistent with the typical temporal pattern described in previous studies. Neurological symptoms such as circumoral numbness, tinnitus, metallic taste, dizziness, agitation, and generalized seizures were the earliest manifestations in most patients, whereas cardiovascular abnormalities including hypotension, bradycardia, and ventricular arrhythmias occurred in patients with more severe toxicity. These findings support the classical progression of LAST from central nervous system excitation to cardiovascular depression described in the literature.[2,5,6]

The pathophysiology of LAST is related to elevated plasma concentrations of local anesthetic agents resulting from inadvertent intravascular injection or rapid systemic absorption from highly vascular tissues. Local anesthetics initially inhibit inhibitory neuronal pathways within the central nervous system, producing excitatory symptoms such as agitation and seizures. As plasma concentrations continue to rise, widespread neuronal depression and myocardial sodium channel blockade occur, resulting in impaired cardiac conduction, myocardial depression, hypotension, ventricular arrhythmias, and cardiovascular collapse. Highly lipophilic local anesthetics, particularly bupivacaine, possess greater cardiotoxic potential because of their prolonged binding to myocardial sodium channels.[1,3,7]

Several patient- and procedure-related factors contribute to the development of LAST. Excessive drug dosage, intravascular injection, injection into vascular anatomical sites, advanced age, hepatic dysfunction, cardiac disease, pregnancy, low body weight, and reduced plasma protein binding have all been identified as important risk factors. Although ultrasound guidance reduces the incidence of vascular puncture, it cannot reliably detect all intravascular needle placements. Consequently, adherence to preventive measures including careful dose calculation, incremental injection with repeated aspiration, continuous patient communication during injection, and close physiological monitoring remains essential.[3,8-10]

Prompt recognition and immediate management are the key determinants of successful outcomes in patients with LAST. Current American Society of Regional Anesthesia and Pain Medicine (ASRA) guidelines recommend immediate discontinuation of local anesthetic administration, airway stabilization, administration of 100% oxygen, early seizure control with benzodiazepines, cardiovascular support using modified advanced cardiac life support protocols, and prompt initiation of 20% intravenous lipid emulsion therapy. Lipid emulsion acts as a "lipid sink," sequestering lipophilic local anesthetic molecules from target tissues while simultaneously improving myocardial energy utilization and cardiac function.[2,6,11]

All patients in the present series received immediate supportive care, including oxygen therapy, seizure control, hemodynamic stabilization, and early intravenous lipid emulsion therapy. None of the patients required prolonged cardiopulmonary resuscitation, and complete neurological and cardiovascular recovery was achieved without permanent sequelae. These favorable outcomes reinforce the importance of early diagnosis and strict adherence to established treatment algorithms. Similar outcomes have been reported in previous case reports and registry-based studies evaluating early lipid emulsion therapy for LAST.[6,11-13]

Preventive strategies remain fundamental in minimizing the occurrence of LAST. Ultrasound-guided needle placement, appropriate selection of local anesthetic dose according to patient weight, incremental injection with frequent aspiration, use of epinephrine-containing test doses when appropriate, continuous monitoring during and after injection, and immediate availability of lipid emulsion in all areas performing regional anesthesia are strongly recommended. Regular simulation-based training of anesthesia personnel further improves preparedness for recognizing and managing this rare but potentially fatal emergency.[2,3,10,14]

The principal limitation of this case series is the small sample size and descriptive study design, which limit the generalizability of the findings. Nevertheless, the series illustrates the spectrum of neurological and cardiovascular manifestations associated with LAST following peripheral nerve blocks and demonstrates that early recognition combined with prompt lipid emulsion therapy can result in excellent clinical outcomes. Reporting such cases contributes to increased awareness among anesthesiologists and reinforces adherence to evidence-based management recommendations.[16-20]

Overall, this case series emphasizes that local anesthetic systemic toxicity, although uncommon, remains an important perioperative emergency associated with peripheral nerve injection blocks. Vigilant patient monitoring, meticulous injection techniques,

early recognition of warning signs, immediate initiation of lipid emulsion therapy, and adherence to established ASRA guidelines are essential to minimize morbidity and mortality and ensure optimal patient outcomes.[2,11,15]

Summary

Local anesthetic systemic toxicity (LAST) is a rare but potentially life-threatening complication associated with peripheral nerve blocks. Despite advances in ultrasound-guided regional anesthesia and improved safety practices, inadvertent intravascular injection or excessive systemic absorption of local anesthetic agents may still result in severe neurological and cardiovascular toxicity. This case series highlights five patients who developed varying degrees of LAST following peripheral nerve block administration. Clinical manifestations ranged from early neurological symptoms, including circumoral numbness, tinnitus, metallic taste, agitation, and seizures, to severe cardiovascular complications such as hypotension, bradycardia, ventricular arrhythmias, and cardiovascular instability. Early recognition, prompt airway stabilization, seizure control, cardiovascular support, and timely administration of 20% intravenous lipid emulsion therapy resulted in complete recovery in all patients without permanent neurological or cardiac sequelae. These cases emphasize the importance of meticulous injection techniques, continuous patient monitoring, adherence to evidence-based treatment protocols, and immediate availability of lipid emulsion wherever regional anesthesia is performed.

Conclusion

Local anesthetic systemic toxicity remains a rare but critical emergency in regional anesthesia that requires rapid diagnosis and immediate intervention. Although modern ultrasound-guided techniques have significantly improved the safety of peripheral nerve blocks, they cannot completely eliminate the risk of systemic toxicity. Vigilant patient monitoring, appropriate dose calculation, incremental injection with repeated aspiration, and strict adherence to established safety guidelines are essential preventive measures. Early administration of intravenous lipid emulsion, together with supportive airway and cardiovascular management, remains the cornerstone of successful treatment and is associated with excellent clinical outcomes. This case series reinforces the need for continued awareness, preparedness, and simulation-based training among anesthesiologists to ensure prompt recognition and effective management of LAST, thereby minimizing morbidity and mortality associated with this potentially fatal complication.

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