

Complications of peripheral nerve blocks

Peripheral Nerve Injury

- Nerve injury
- Hematoma
- Local Anesthetic systemic toxicity
- Infection
- Secondary injury
- Anatomic considerations
- Needle choices
- Preexisting pathology

Peripheral nerve injury (1)

- An infrequent complication of regional anaesthesia
- Retrospective studies estimate an incidence of 0.5–1.0%,
- One prospective study suggests an incidence of 10–15%.
- Incidence clearly depends on the definition of nerve injury.
- Permanent nerve damage = 1.5/10 000
- The incidence of transient neurological deficits is higher, incidence of transient paraesthesia might be as high as 8–10% in the immediate days following the block

- Intraneural injections were once considered forerunners of neural injury
- They occurred despite the use of nerve stimulation (NS) or ultrasound (US) guidance
- The use of US guidance...*have learned that intraneural injections do not necessarily result in permanent injury*

- US guidance has greatly improved the success, onset, and quality of peripheral nerve blocks
- Low incidence of major complications and the heterogeneity of studies performed, it is difficult to conclude that US guidance improves the safety of peripheral nerve blocks.
- *I can see ..*but it is interesting that the incidence of neurological injury related to peripheral nerve blocks has not decreased

A study of more than 7000 peripheral nerve and plexus blocks

- ✓ US (13%), NS (30%), US with NS (50%), and other (7%) techniques
- ✓ 30 patients (0.5%) were referred for neurological assessment.
- ✓ only three met criteria for nerve injury related to peripheral nerve block (0.04% incidence)

Although this does not demonstrate that US improves the safety of blocks, it confirms that postperipheral nerve block neurological deficits are indeed rare, and reminds us that neurological follow-up until resolution or stabilization of the condition is mandatory

Unavoidability of intraneural injections

- NS cannot prevent injection into a motor fascicle, and paraesthesias do not prevent injection into a sensory fascicle
- NS and paraesthesia techniques have low sensitivity for localizing nerves— 38.2% for paresthesias and 74.5% for motor response to PNS.
- More recently, a stimulation current of 0.2 mA or less was found to be reliable for detection of intraneural placement of the needle
- Currents of 0.2–0.5 could not rule out intraneural position

- *It might be unnecessary to avoid intraneural injections, and in fact could be preferable to inject below the epineurium.*
- *Robards and colleagues* studied 24 patients having popliteal sciatic nerve blocks, with a technique that involved either NS with a 'twitch' achieved between 0.2 and 0.5 mA or intraneural needle placement visualized by US.
- In 20 of the patients, the needle was seen below the epineurium before motor response was elicited by NS, whereas in the remaining four patients, the needle was seen intraneurally without response to NS even at 1.5 mA. All patients in the study had intraneural injections with low pressures of , 20 psi resulting in adequate surgical anaesthesia and no postoperative neurological complications. Therefore, the absence of motor response to NS does not preclude intraneural needle position and seeking NS confirmation of a needle that is seen to be intraneural by US could lead to unnecessary attempts at localization.

Peripheral Nerve Injury (2)

- Rate 8 – 10 % in the days following block, but varies between studies
- Major are transient (days or months)
- Major complications > 6 month = 0,015 – 0,09 %
- With continuous catheters up-to 0,21 %

- Most nerve injury occur (?) intraneural injection
- Intraneural injection maybe extrafascicular or intrafascicular
- Intrafascicular + High pressure greater risk of damage
- US images of intraneural injections have refuted that nerve damage is inevitable (e.g. below epineurium injection)

Additional Risk

- Pre-existing nerve pathology (like diabetes)
- Longer-bellwired needles VS short-bellwired needles
- Continuous visualization with US, *but the reduction of nerve injury not demonstrated*

- A multimodal algorithm that combines ultrasound guidance with nerve stimulation and injection pressure monitoring was recommended by the panelists

Appendix Algorithm A1, <http://links.lww.com/COAN/A25>.

- Ultrasound is used to visualize the relevant anatomy in order to guide the needle tip to the desired location while avoiding needle–nerve contact and/or **intrafascicular injection**.

- Risk for local anaesthetic systemic toxicity (LAST) may be reduced by ultrasound monitoring, as an intravascular injection can be suspected by the absence of local anaesthetic spread in the expected space

- Although ultrasound may detect an intraneural injection by an increase in the diameter of the nerve and proximal-distal distribution, the perineurium can rupture with a miniscule amount of injectate, making ultrasound alone inadequately sensitive to reliably prevent an intrafascicular injection
- The primary role of nerve stimulation in combination with ultrasound guidance is to help detect an inadvertent needle nerve contact, intraneural or intrafascicular needle placement.
- The panel concurred that the presence of a motor response at a current of 0.3mA or less (0.1ms) indicates a needle–nerve contact or an intraneural needle placement [12]. More practically, a nerve stimulation can be set at 0.5mA (0.1ms). Therefore, when a motor response is present at 0.5, the panel suggests that the needle be repositioned until the motor response disappears

Standard approaches for upper extremity nerve blocks with an emphasis on outpatient surgery
Kwesi Kwofie, Uma Shastri, and Catherine Vandepitte
Curr Opin Anesthesiol 2013, 26:501–508

- The panel suggested that when the ultrasound imaging of the needle and anatomy are adequate, it is not necessary to elicit an evoked motor response before injection. However, an evoked motor response can be sought intentionally to confirm nerve location or when imaging quality is suboptimal.
- High opening pressure during injection pressure monitoring can detect needle placement into noncompliant tissues (such as the nerve fascicle) or needle–nerve contact. Therefore, when high opening pressure (>15psi) is obtained before the injection commences, the needle should be repositioned before proceeding with the injection.
- In summary, for all the techniques described, triple monitoring (ultrasound, nerve stimulation, injection pressure) is suggested. Injection is commenced if no motor response is present at a current less than 0.5mA, opening pressure less than 15psi and after negative aspiration test for blood to rule out an intravascular needle placement.

Ultrasound guidance, a win-win approach to peripheral nerve blockade

[Jochum D¹](#), [Iohom G](#), [Bouaziz H](#).

[Curr Opin Anaesthesiol](#). 2013 Aug 19.

Abstract

PURPOSE OF REVIEW:

The objective of the current review is to examine the likelihood of improved safety in peripheral nerve blockade attributable to ultrasound guidance.

RECENT FINDINGS:

With ultrasound guidance, a 10-fold reduction in the incidence of local anesthetic systemic toxicity as well as a tendency toward less long-term neuropathies are shown.

SUMMARY:

Ultrasound is clearly superior to other techniques with the aim of achieving maximum efficacy with minimum risk: a win-win approach.

PMID: 23963233

Local anaesthetic systemic toxicity

LAST

Local anaesthetic systemic toxicity (LAST) ranges from:

- **mild systemic symptoms** (auditory changes, circumoral numbness, metallic taste, and agitation)
- **central nervous system (CNS) findings** (seizure, coma, respiratory arrest)
- **cardiovascular events** (hypertension, hypotension, tachycardia, bradycardia, ventricular arrhythmias, cardiac arrest)

LAST

- However, LAST continues to be a major source of morbidity and mortality in the practice of regional anaesthesia
- LAST is a potentially fatal complication of regional anesthesia occurring in up to 1/500 peripheral nerve blocks
- In the past, treatment was supportive
- Intravenous lipid emulsion (ILE) has emerged over the past decade as a promising antidote to local anesthetic systemic toxicity (LAST)

LAST

- 15 yr ago Weinberg described his observation that pre-local anaesthetic administration or post-arrest treatment with lipid emulsion infusion shifts the dose–response to bupivacaine-induced asystole in rats
- LD 50 for bupivacaine was 12.5 mg kg⁻¹ in rats treated with saline and 18.5 mg kg⁻¹ when resuscitated with lipid emulsion.

LAST

- The first use of lipid emulsion infusion to treat LAST in humans was reported in 2006*
- Only after infusion of 100 ml of 20% lipid emulsion did the patient recover a perfusing cardiac rhythm, and he had no neurological sequelae
- To date, there have been more than 10 case reports describing the successful treatment of LAST with lipid infusions, and also multiple reports in humans and animal models of using lipid infusions to treat toxicity from other lipophilic agents, including verapamil, clomipramine, propranolol, lamotrigine, amfebutamone, and haldoperidol. 73

**Rosenblatt MA, Abel M, Fischer GW, Itzkovch CJ, Eisenkraft JB.*

Successful use of a 20% lipid emulsion to resuscitate a patient after a presumed bupivacaine-related cardiac arrest. Anesthesiology 2006; 105: 217–8

Mechanism of lipid rescue

- The exact mechanism of lipid rescue has yet to be elucidated
- The theory of the infusion acting as a 'lipid sink', drawing the local anaesthetic into the lipid layer, is attractive
- There might also be metabolic advantages to using lipid
- The safety of large-dose lipid emulsion therapy has yet to be established.
- All doses of lipid administered in this study* were in excess of those used for lipid rescue in humans.

**Hiller DB, Di Gregorio G, Kelly K, et al. Safety of high volume lipid emulsion infusion. A first approximation of LD 50 in rats. Reg Anesth Pain Med 2010; 35: 140–4*

LAST

- **LAST** remains an unavoidable and probably the most feared complication of regional anaesthesia
- Vigilance during the performance of regional anaesthetics and prompt intervention at the earliest signs of toxicity are most important in successful treatment
- lipid infusion has become a standard early in the management of symptoms.
- Research continues in order to determine the optimal dosage of lipid emulsion and also the most favourable combination with other resuscitation agents to ensure patient safety and to improve outcomes.

ASRA Practice Advisory on Local Anesthetic Systemic Toxicity

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Abstract:

The American Society of Regional Anesthesia and Pain Medicine Practice Advisory on Local Anesthetic Systemic Toxicity assimilates and summarizes current knowledge regarding the prevention, diagnosis, and treatment of this potentially fatal complication. It offers evidence-based and/or expert opinion-based recommendations for all physicians and advanced practitioners who routinely administer local anesthetics in potentially toxic doses. The advisory does not address issues related to local anesthetic-related neurotoxicity, allergy, or methemoglobinemia. Recommendations are based primarily on animal and human experimental trials, case series, and case reports. When objective evidence is lacking or incomplete, recommendations are supplemented by expert opinion from the Practice Advisory Panel plus input from other experts, medical specialty groups, and open forum. Specific recommendations are offered for the prevention, diagnosis, and treatment of local anesthetic systemic toxicity.

Reg Anesth Pain Med 2010;35: 152Y161

Resuscitation with lipid infusions

- Airway management
- Seizure suppression
- BCLS/ACLS
 - Use small initial doses of epinephrine (10 –100 mcg boluses) ?
 - (*Vasopressin is not recommended*)
 - Avoid calcium channel blockers, beta-adrenergic blockers, and
 - local anaesthetics (lidocaine, procaine)
- Consider lipid emulsion therapy at first signs of LAST
 - 1.5 ml kg⁻¹ bolus of 20% lipid emulsion
 - Infusion at 0.25 ml kg⁻¹ per min for at least 10 min after return
 - of circulatory stability
 - Consider giving a second bolus and increasing infusion to
 - 0.50 ml kg⁻¹ if circulatory stability not attained
 - Upper limit of lipid emulsion recommended is 10 ml kg⁻¹ over
 - the first 30 min
- (*Consider cardiopulmonary bypass if lipid emulsion treatment fails*)



AMERICAN SOCIETY OF REGIONAL ANESTHESIA AND PAIN MEDICINE

Checklist for Treatment of Local Anesthetic Systemic Toxicity

The Pharmacologic Treatment of Local Anesthetic Systemic Toxicity (LAST) is Different from Other Cardiac Arrest Scenarios

- Get Help**
 - Initial Focus**
 - Airway management:** ventilate with 100% oxygen
 - Seizures uppression:** benzodiazepines are preferred; **AVOID propofol** in patients having signs of cardiovascular instability
 - Alert** the nearest facility having **cardiopulmonary bypass** capability
 - Management of Cardiac Arrhythmias**
 - Basic and Advanced Cardiac Life Support (ACLS)** will require adjustment of medications and perhaps prolonged effort
 - AVOID vasopressin, calcium channel blockers, beta blockers, or local anesthetic**
 - REDUCE individual epinephrine doses to <1 mcg/kg**
 - Lipid Emulsion (20%) Therapy** (values in parenthesis are for 70kg patient)
 - Bolus 1.5 mL/kg** (lean body mass) intravenously over 1 minute (~100mL)
 - Continuous infusion 0.25 mL/kg/min** (~18 mL/min; adjust by roller clamp)
 - Repeat bolus once or twice for persistent cardiovascular collapse
 - Double the infusion rate to 0.5 mL/kg/min if blood pressure remains low
 - Continue infusion** for at least 10 minutes after attaining circulatory stability
 - Recommended upper limit: Approximately 10 mL/kg lipid emulsion over the first 30 minutes
 - Post LAST events** at www.lipidrescue.org and report use of lipid to www.lipidregistry.org
-

Checklist for Treatment *of Local Anesthetic Systemic Toxicity*

- BE prepared
 - **establish a plan for managing this complication**
- BE sensible - RISK REDUCTION
 - Use the least dose of LA necessary to achieve the desired extent and duration of block
 - Local anesthetic blood levels are influenced by site of injection dose and other factors (age, heart failure, low protein conc.,)
 - Consider using a pharmacologic marker and/or test dose, e.g. epinephrine 5 mcg/mL of LA.
 - Aspirate the syringe prior to each injection while observing for blood.
 - Inject incrementally, while observing for signs and querying for symptoms of toxicity between each injection.
- BE vigilant – DETECTION
 - Use standard American Society of Anesthesiologists (ASA) monitors.
 - Monitor the patient during and after completing injection as clinical toxicity can be delayed up to 30 minutes.
 - Communicate frequently with the patient to query for symptoms of toxicity.
 - Consider LAST in any patient with altered mental status, neurological symptoms or cardiovascular instability after a regional anesthetic.

Remember...

- Central nervous system signs (may be subtle or absent)
 - Excitation (agitation, confusion, muscle twitching, seizure)
 - Depression (drowsiness, obtundation, coma or apnea)
 - Non-specific (metallic taste, circumoral numbness, diplopia, tinnitus, dizziness)
- Cardiovascular signs (often the only manifestation of severe LAST)
 - Initially may be hyperdynamic (hypertension, tachycardia, ventricular arrhythmias)
 - Progressive hypotension
 - Conduction block, bradycardia or asystole
 - Ventricular arrhythmia (ventricular tachycardia, Torsades de Pointes, ventricular fibrillation)
- *Sedative hypnotic drugs reduce seizure risk but even light sedation may abolish the patient's ability to recognize or report symptoms of rising LA concentrations*

TREATMENT

- Timing of lipid infusion in LAST *is controversial*
 - Infusing lipid at the earliest sign of LAST can result in unnecessary treatment since only a fraction of patients will progress to severe toxicity.
 - The most reasonable approach is to implement lipid therapy on the basis of clinical severity and rate of progression of LAST
- *Epinephrine can impair resuscitation from LAST and reduce the efficacy of lipid rescue.*
 - *Avoid high doses of epinephrine and use smaller doses, e.g., <1mcg/kg, for treating hypotension.*
- Propofol should not be used when there are signs of cardiovascular instability. Propofol is a cardiovascular depressant with lipid content too low to provide benefit. Its use is discouraged when there is a risk of progression to cardiovascular collapse.
- Prolonged monitoring (> 12 hours) is recommended after any signs of systemic LA toxicity, since cardiovascular depression due to local anesthetics can persist or recur after treatment.

A Survey of Knowledge Relating to the Causes, Signs and Treatment of Local Anaesthetic Toxicity (LAST)

Abstract Number: A138

Abstract Type: Regional Anesthesia

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Introduction: Local anaesthetics are commonly used within the operating theatre suite to provide intra and post operative analgesia. This may be via a number of routes including epidural, peripheral nerve block and subcutaneous infiltration.

Local anaesthetic toxicity (LAST) is rare, with an incidence of 0.08 per 1000 quoted by Sites¹, but potentially fatal. Avoidance of LAST requires knowledge of safe maximum doses of drugs, recognition and of appropriate treatment. The use of lipid emulsion to treat LAST has been understood for many years, and more recently been incorporated into several guidelines including those from the AAGBI³ in the U.K. and ASRA in North America². Despite the increased availability of lipid emulsion in the U.K over the last ten years, knowledge of its use is often variable.

We sought to assess the level of understanding of local anaesthetic doses and the effective management of LAST within a busy University Hospital anaesthetic department.

Methods: A confidential questionnaire was distributed amongst both trainee anaesthetists and consultant anaesthetists over a one-week period within the anaesthetic department.

Questions assessed knowledge of maximum local anaesthetic doses, signs and symptoms of local anaesthetic toxicity, the awareness of guidelines used to treat LAST and the dosages and availability of Intralipid (lipid emulsion therapy).

Results: 18 anaesthetic trainees and 20 anaesthetic consultants participated in the questionnaire.

82% correctly identified the correct maximum safe dose of both lignocaine and bupivacaine, although when asked only 61% were able to translate this to an appropriate volume of 2% lignocaine.

100% of anaesthetists correctly identified both the neurological and cardiac signs of LA toxicity.

100% were aware of the availability of guidelines and the use of Intralipid to treat LAST.

Only 12%, however, were able to state the loading, maintenance and maximum dose of Intralipid and only 40% correctly identified where it was kept.

Conclusion: Those using local anaesthetic should know the maximum safe dosages to avoid LAST and how to manage LAST accordingly.

This group had a good understanding of maximum safe doses of local anaesthetics, however failings were demonstrated when asked to translate this into a clinical volume for use.

The ability to recognise LAST was well demonstrated by the knowledge of signs and symptoms relating to LAST.

The awareness of guidelines and the use of Intralipid to treat LAST was evident but there was still a lack of knowledge on how to use Intralipid appropriately and where to find it.

Further to these results we propose an intervention of training in the use of Intralipid and a subsequent re-audit of knowledge.

References:

1. Sites, Brian Daniel et al. Incidence of Local Anesthetic Systemic Toxicity and Postoperative Neurologic Symptoms Associated With 12,668 Ultrasound-Guided Nerve Blocks: An Analysis From a Prospective Clinical Registry. RAPM 2012; 37(5) 478-482
2. Management of Severe Local Anaesthetic Toxicity 2, Association of Great Britain and Ireland, published December 2010.
3. Neal JM et al American Society of Regional Anesthesia and Pain Medicine checklist for managing local anesthetic systemic toxicity: RAPM 2012 37(1)

Local anesthetic toxicity and lipid resuscitation in pregnancy

Sarah Bern a and Guy Weinberg a,b

Current Opinion in Anesthesiology 2011,24:262–267

Purpose of review

Lipid emulsion has emerged as an effective treatment of local anesthetic-induced cardiac arrest, but its therapeutic application for the obstetric patient requires definition at present. This review discusses clinical reports, relevant laboratory studies, and future directions for the development of an optimal protocol for lipid resuscitation in pregnancy.

Summary

As the obstetric demographic becomes older and more obese, new technologies and strategies can assist in controlling maternal death and major morbidity secondary to anesthesia complications. Lipid resuscitation appears to be an effective treatment for toxicity induced by lipophilic medications and may be useful in treating systemic toxicity in the pregnant patient. Obstetric care providers should be aware of lipid resuscitation and consider its use as described by American Society of Regional Anesthesia and Pain Medicine guidelines.

LipidRescue™

Salvataggio Lipidico

TRATTAMENTO DELL'ARRESTO CARDIACO INDOTTO DA ANESTETICI LOCALI
ATTENZIONE: TENERE QUESTO PROTOCOLLO ATTACCATO ALLA SACCA DI INTRALIPID

Nel caso di arresto cardiaco indotto da anestetici locali non responsivo alla terapia standard, in aggiunta al protocollo di rianimazione cardiopolmonare, dovrebbe essere somministrato e.v. intralipid 20% nei seguenti dosaggi:

- Intralipid 20% 1.5 mL/kg in 1 minuto
- Iniziare immediatamente dopo un'infusione alla velocità di 0.25 mL/kg/min
- Non interrompere le compressioni toraciche (i lipidi devono entrare in circolo)
- Ripetere il bolo ogni 3-5 minuti fino a 3 mL/kg di dose totale fino alla ripresa della circolazione spontanea
- Continuare l'infusione fino a che non si è raggiunta la stabilità emodinamica. Aumentare la dose a 0.5 mL/kg/min se la pressione arteriosa tende a diminuire
- La dose massima raccomandata è di 8 mL/kg

In pratica, nella rianimazione di un adulto di 70kg di peso:

- Prendere una sacca da 500 ml di Intralipid 20% e una siringa da 50 ml.
- Aspirare e somministrare subito 50 ml e.v. per 2 volte
- Connettere la sacca di Intralipid a un set da infusione e somministrarla e.v. nei successivi 15 minuti
- Ripetere il bolo iniziale fino a un massimo di altre due volte se non vi sarà ripresa di circolazione spontanea.

In caso di utilizzo di Intralipid nel trattamento di un caso di tossicità da anestetici locali, segnalarlo sul sito www.lipidrescue.org

Linee Guida per la Rianimazione Cardiopolmonare

Linee Guida ERC 2010



Italian Resuscitation Council



- Tossicità sistemica che coinvolge il SNC e sistema cardiovascolare
- Tossicità può essere aumentata il gravidanza, nel bambino, nell'anziano e in presenza di ipossiemia
- I pazienti che presentano LAST possono trarre beneficio dalla somministrazione di lipidi al 20%, in aggiunta alle manovre ACL standard
- Vanno somministrati gli usuali farmaci impiegati nel caso di ACC, secondo le linee guida, anche se studi condotti su animali dimostrano deboli evidenze, nel caso di LAST