Case Report

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Lipid Emulsion for Spinal Anaesthesia Reversal — A Therapeutic Option

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ABSTRACT

High spinal anaesthesia is also one of the commonly faced problems, with a low incidence of a complete spinal block; which is one of the life-threatening complications unless immediately identified and treated. Up to now, its management has relied mainly on intensive means such as respiratory and circulatory assistance.

Intravenous lipid emulsions have an established position in the management of local anesthetic toxicity. After the success in this area, ILE has been used under clinical conditions for various kinds of overdose. At present, ILEs are expanding into a new field, that of reversing the effects of local anesthesia on peripheral nerves and neuraxial anesthesia.

We report two cases of patients operated at our department, the first for genital prolapse under perimedullary anaesthesia, complicated by high spinal anaesthesia. The second case was a patient who underwent Caesarean section under spinal anaesthesia, intubated mid-operatively and presented with postoperative delayed awakening. Both complications were resolved by intralipid injection.

We then reviewed the literature concerning similar cases and the different means used to resolve the problem.

Keywords

Lipid emulsion infusion, Local anesthetics, High spinal anesthesia, Genital prolapse.

Background

The first indication for intravenous lipid emulsions was parenteral nutrition, as early as the 1960s. Over the last ten years or so, there has been growing interest in ELIs in clinical toxicology, and their use is now recommended in the treatment of acute intoxication by local anesthetics [1].

High or total spinal anaesthesia often results from the injection of excessive doses with local anaesthetic into the epidural catheter when it is accidentally placed in the intrathecal space.

We report a 3rd case involving a patient who underwent surgery for a gynaecological problem under perimedullary anaesthesia, complicated by high anaesthesia and managed by intravenous injection of lipid emulsion. These 3 cases are among the first published in the literature concerning the use of LEI to reverse central or peripheral neuraxial anaesthesia.

Cases presentation

Written informed consent was obtained from both patients.

First case

Patient T. H was 51 years old, married with four children, G4P4, with no particular medical or surgical history. She has been experiencing progressive organ falling for 2 years, the symptom being more marked in prolonged standing position. Which motivated the patient to consult the gynecologist who diagnosed in her a genital prolapse classified (Cystocele C4, Hysterocele H3, Elytrocele E1, Rectocele R1, Urinary incontinence I0) according to the Baden-Walker classification. Hence her referral to our

hospital for surgical management.

The pre-operative examination found the patient in good general condition, a BMI of 18 kg/m^2 (42 kg/1.53 m). The clinical and biological examination was without particularities, the patient was classified ASAI according to the American Society of Anesthesiologists. Subsequently, our patient was scheduled for surgical treatment, according to the direct plasty technique as an ambulatory, under combined spinal-epidural anesthesia.

In the operating room, after standard monitoring and in the seated position, spinal puncture followed by catheter placement was performed without difficulty in the L4 − L5 space, she had received in spinal anesthesia 10 mg of isobaric bupivacaine, combined with 2.5 mcg of sufentanyl and 100 mcg of morphine. The patient was immediately placed in a supine position, the quality and the level of the sensory block were assessed by a hot/cold test. In order to ensure sufficient anesthesia during the vaginal prolapse cure, a blockage of the sensory levels from T10 to S5 is necessary, which was obtained within 5 min, correlated to a Bromage score equal to 1 (partial motor block). After placing the patient in the gynaecological position, the main surgical procedures include a hysterectomy followed by repair of the cystocele.

After 45 min, the patient had started to feel pain (VAS = 8/10) during the surgical manipulation with a sensitivity level below T10 and a disappearance of the motor block (Bromage at zero). This required an injection of 25 mg bupivacaine 0.5% into the epidural space through the catheter in place, enabling the surgery to be continued.

After 85 min, surgical pain reappeared (VAS = 7/10), leading to a second epidural injection of 25 mg bupivacaine, enabling the operation to be completed under good conditions. The operative time was 130 min.

At one hour from discharge to the post-interventional care unit, our patient presented: cold extremities, dyspnea with bradypnea at 10 c/min, cyanosis of the extremities with SPO2 at 60%, blood pressure at 100/54 mmhg and heart rate at 120 c/min, sensory block at T6 and complete motor block (Bromage at 3). Initial measures included trunk elevation, high-flow oxygen therapy (10 l/min) and rewarming.

Two hours after admission to the post-interventional care unit: persistence of cold extremities, dyspnea (low SPO2) and same sensory-motor level. In view of this worrying situation, it was decided to use a lipid emulsion to try to antagonize the LA with 3 ml/kg Intralipid® 20%, by intravenous injection. Our patient received 2 boluses of 50 ml and 5 min later there was a progressive improvement in SPO2 until its normalized after 10 min. Motor block disappeared within 30 minutes and sensory block within 40 minutes. Since then, the patient has remained well stabilized, with no complications. The following day, the patient was discharged from hospital with a one month consultation appointment.

Second Case

Patient N.K, 32 years old, 165cm, 85 weight, G4P1, history of abortion and vaginal delivery. She has presented a healthy pregnancy of 38 weeks and 4 days of gestation, admitted to the delivery room in early labor, 4 hours after dilation remained stationary with the appearance of fetal distress, hence the indication for emergency cesarean section.

Spinal anesthesia was performed at L4-L5 in the sitting position using 10 mg of 0.5% isobaric Bupivacaine + sufentanyl 2.5 mcg + Morphine 100 mcg. Once the spinal anesthesia has been successfully installed at the appropriate level (T4), the operators proceed with the surgical incision, plane by plane, up to the hysterotomy enabling the baby to be extracted.

A few minutes after uterine closure, the patient begins to complain of discomfort and anxiety, despite a sensory level at T5. The anesthesiologist in charge initiated sedation with repeated doses of propofol, without satisfactory results. Therefore, a general anaesthesia (fentanyl + propofol) with orotracheal intubation was practiced on her, which facilitated the continuation and completion of the caesarean section under good conditions, the operation lasting 40 min. Postoperatively, the patient presented delayed awakening for around 4 h with disturbed consciousness, agitation, mild ocular miosis and inefficient chest-abdominal spontaneous breathing with partial motor block (Bromage at 2). Attempts at naloxone antagonization were accompanied by adverse effects such as tachycardia and arterial hypertension, with no improvements in the patient's neurological and respiratory status. The anesthesiologist decided to treat with ILE 20% (100 ml IV), five minutes later the patient resumed effective spontaneous breathing, then 10 min later a satisfactory state of consciousness, leading to her extubation and transfer to the post-interventional care unit. Subsequently, at 30 min, motor block disappeared (Bromage at 0).

The following day, the patient was discharged from hospital in good health with a one month consultation appointment.

Discussion

Two major problems remain frequently encountered in the current practice of anesthesiologists, concerning perimedullary anesthesia and peripheral nerve block. Firstly, high spinal anesthesia, which can lead to a level of sensory-motor and sympathetic block that can lead to cardiovascular and respiratory failure, which can seriously compromise the patient's safety. Secondly, prolonged motor block in perimedullary and peripheral anesthesia is associated with longer hospital stays in the post-interventional care unit, patient dissatisfaction and increased health care costs.

However, as there are anesthetics additives (morphinics, adrenaline, clonidine, etc.), to potentiate the effect of local anesthetics (LA) in duration and effectiveness. On the other hand, are there any molecules that can shorten their effects?

Very few scientists have taken an interest in this field, and the molecules used remain in the realm of research, namely alpha-blockers for dental local anesthesia reverse, insulin for peripheral nerve blocks, lavage fluids for the epidural space or intravenous lipid emulsions for locoregional anesthesia reverse.

As part of odontological anesthesia, the administration of local anaesthetic is an essential procedure prior to dental treatment, to minimize the resulting pain. Its effect is known to last longer than the time required for the dental care. This prolonged anesthesia can be detrimental, with a negative influence on the quality of life (speaking, eating, negative body image) mainly for some individuals, such as children, the elderly and patients with special needs. For this reason, the dentists use an alpha-blocker (phentolamine) to increase regional blood flow to shorten nerve conduction in the oropharynx, thus providing proof of principle that nerve blocks can be shortened [2].

Method of substituting cerebrospinal fluid (CSF) with saline solution. Some studies have focused on the concept of crystalline lavage solution at injection sites of local anesthetics, such as the epidural space, to induce faster recovery from sensory-motor block. This CSF lavage technique has already been described in the literature to limit the neurotoxicity of accidental intrathecal administration of vincristine; dilution of the local anesthetic administered via the spinal route is the concept that inspires this procedure [3].

Tsui et al, described the method of CSF lavage in a 14 year old girl who underwent general anesthesia combined with epidural anesthesia for orthopedic surgery. In this case, a large amount of local anesthetic was injected intrathecally (200mg lidocaine and 61mg bupivacaine), which caused apnea and fixed pupil dilation at the end of the operation. We substituted 20 ml CSF for 10 ml saline solution combined with 10 ml lactated Ringer's solution. Spontaneous breathing resumed 5 minutes later, and the patient was extubated after 30 minutes, with no sequelae [4].

Sitzman et al, conducted a randomized double-blind comparative study in 33 patients scheduled for gyneco--obstetric surgery under epidural anesthesia, using 2% Lidocaine combined with epinephrine (1:200,000) as an adjuvant. Postoperatively, patients were divided into 3 groups to receive in the epidural catheter: group 1 (n=10, 15 ml of isotonic serum solution); Group 2 (n=10, 15 ml of isotonic serum solution, then 15 min later another bolus of 15 ml isotonic serum solution) and group 3 (n=11, control). Partial and total motor and sensory recovery times were significantly faster in the epidural lavage solution groups than in the control group. In addition, recovery was faster in subjects who received 2 boluses [5].

Johnson et al, their comparative study aimed at determining reversibility of motor block secondary to injection of crystalloid solutions via the epidural catheter in twenty-seven patients scheduled for caesarean section under epidural anaesthesia with 0.75% bupivacaine. Postoperatively, the patients were randomized into 2 groups, the first receiving three injections of 15 ml saline solution for the 30 minute period, and the second receiving no lavage solution (control group). Time to resolution of motor block was more than twice as long in the control group [6].

These results suggest that CSF lavage could potentially be an important and useful adjunct to conventional management of patients with abnormally prolonged motor block in perimedullary anesthesia in the event of accidental high or total spinal anesthesia.

Insulin's role, Kim JM et al published a study aimed to determine whether insulin has an effect on the reversibility of peripheral nerve block, by comparing 2 groups of rats that all received a local anesthetic to block the sciatic nerve in association with either isotonic serum solution in the first group or insulin in the second. The results showed that the sensory-motor block disappeared more rapidly in the insulin group than in the isotonic serum solution group, with a significant difference ($p < 0.01$) [7].

The first successful use of ILE in the anesthesiology field dates back to 1962, when it was used to shorten the thiopental anesthesia duration, following its experimental administration to rats [8].

Several cases of LA intoxication associated with prolonged peripheral nerve block or following total spinal anesthesia (SA) have been reported in the literature. Coincidentally, the ILE employed, with the intention of curbing systemic LA toxicity, were followed by the concomitant disappearance of signs of systemic toxicity and peripheral nerve block and/or total SA.

As the study reports from the team of Ihab et al, published in 2015 a case of LAST associated with accidental sensory-motor block of the left lower limb, occurring during analgesic infiltration through the surgical site of a genital prolapse, with an excessive dose of 0.5% bupivacaine (80ml), which led to its passage to the inadvertent femoral and obturator nerves and their blocking. However, administration of ILE resulted in concomitant resolution of LAST signs and peripheral nerve block [9].

Turner et al, published in 2019, the case of a 56 year old woman who benefited from bone spur removal of the left shoulder under general anesthesia with interscalene nerve block, secondarily complicated by bilateral mydriasis, tetraplegia, and respiratory arrest. She was intubated and ventilated, then given ILE, which led to complete recovery of central and peripheral neurological function [10].

Another case published in 2020 by Arissa et al, where their patient presented an apparent reversal of a successful peripheral neural blockade with ILE after treatment for local anesthetic systemic toxicity [11].

There are few published cases of the intentional use of ILE to lift peripheral or central nerve block.

Eldor and coll, reports their experience of successful anesthetic reversal by ILEs through three cases to counteract high spinal anesthesia; four cases to reverse peripheral nerve blocks invoving the brachial plexus and three cases to accelerate sensory─motor recovery after spinal anesthesia [12].

In our department, we have already published two cases in 2021 in which ILEs were successfully used to counteract an abnormal prolongation of spinal anaesthesia performed for diagnostic hysteroscopy in a patient with multiple sclerosis-type neuropathy in remission, and the second for high spinal anaesthesia following accidental injection with an excessive dose of local anaesthetic into the intrathecal space [13,14].

Mechanism of ILE action

The most widely accepted mechanism is that the ILE intravascular action consists in creating a concentration gradient that favors the local anesthetics (LA) redistribution to the extracellular sector. Lipid vesicles then encapsulate the LA (creating lipid sinks) and the formation of this "trap" removes the toxins from the various tissues and organs, reducing their bioavailability. Secondary to this pharmacokinetics sequestration mechanism, the LA is rapidly redistributed by "lipid shuttles" to sites of metabolism (liver), storage (adipose tissue) or elimination (kidney) [15].

Conclusion

A new field of ILE action has been identified, that to reversing the effects of local anesthesia on peripheral nerves and neuraxial anesthesia. This hypothesis of efficacy and safety requires more solid scientific research to confirm it.

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APPENDICE: Bromage scale

0 : free movement of legs and feet
1 : just able to flex knees with free movement of feet
2 : Unalable to flex knees, but with free movement of feet
3 : Unable to move legs or feet

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