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An uncommon cause of nerve stimulator's malfunction during a dual guidance lumbar plexus block: a technical brief report and an algorithm for prevention of complications

Short Title: Short circuit during nerve stimulation

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Abstract

Posterior Lumbar plexus block (PLPB) combined with an ipsilateral sacral plexus block is a valuable anaesthetic technique in patients undergoing hip fracture surgery. PLPB is performed through the acoustic window of the lumbar ultrasound trident and the position of the needle tip, before injection of LA, was confirmed by observing quadriceps femoris muscle contraction to peripheral nerve stimulation (i.e., dual guidance). We report an uncommon cause of nerve stimulator malfunction that might impair block performance and promote complications. We add an algorithm to limit the risk of complications.

Introduction

Peripheral nerve blocks are applied worldwide for lower limb surgery^{1,2}. A posterior lumbar plexus block (PLPB) is indicated during hip surgery³. Traditionally, PLPB necessitated the use of nerve stimulation^{4,5}. Recently, ultrasound-guided (USG) lumbar plexus block techniques have been described^{6,7}. USG PLPB is considered as an advanced block technique that might be associated with a risk of serious complications⁴. The lumbar plexus is identified within the posteromedial part of the major psoas muscle anterior to L4 transverse process^{6,7}. The block needle is inserted and advanced until its tip is located adjacent to the lumbar plexus. However, neural structures identification and the needle tip may not be ever visualised. Dual guidance – i.e., the combination of ultrasound and nerve stimulation – recently appears to be the preferred approach in Switzerland⁸ for localising nerves and providing PNB. In daily practice, ultrasound and nerve stimulation are combined for PLPB procedure. Whenever the lumbar plexus is visible or not, the motor response from the quadriceps femoris muscle to electrical nerve stimulation is required as a safety tool⁵.

We report a previously unreported case of malfunction of a nerve stimulator responsible for ineffective electro stimulation during the performance of a USG PLPB in an elderly patient scheduled for surgical repair of a hip fracture. After multiple attempts, a short circuit was diagnosed, and the nerve stimulator replaced. A brief technical review of the causes of malfunction encountered during peripheral nerve stimulation and an algorithm are presented to help for limitation from such adverse events.

Case scenario

An 85-year-old woman, ASAPS IV, was scheduled for surgical treatment of left femoral neck fracture. Medical history included arterial hypertension and a brain stroke. Preoperative treatment included amlodipine, valsartan, hydrochlorothiazide, aspirin, and tramadol. A combination of PLPB, parasacral sciatic and cluneal nerve blocks was selected and the patient consented. In the operating theatre, standard intraoperative monitoring was applied. A combination of 10 mg ketamine and 10 mg propofol was injected intravenously for procedural sedation and analgesia.

The PLPB block was performed while the patient placed in right lateral decubitus position. An anaesthetist experienced in these techniques (O.C.) performed the block using a Logic S8 ultrasound system (General Electric, USA) and a 5–2 MHz curved array transducer. The probe was oriented paramedially, to enable sonoanatomy of the sacrum and the L5 transverse process. By shifting the probe cephalad, the L3, L4, and L5 transverse processes were seen as the “trident sign”^{9,10}. The lumbar plexus was ultrasonographically identified within the posterior part of the major psoas muscle. After skin local anaesthesia with 3 mL of 1% lidocaine, the block needle (21 gauge, 100 mm, UniPlex Nanoline, Pajunk, Geisingen, Germany) connected to the Stimuplex HNS12 peripheral nerve stimulator (B/Braun Medical, Melsungen, Germany) was inserted perpendicular to the skin 3.5 cm laterally to the midline with an out-of-plane approach. The nerve stimulator was turned on and set as a detection device (0.1 ms, 1 Hz, 1.5 mA) and the needle advanced to place the tip of the needle close to L4 nerve root. The needle tip was detected by ultrasonography close to the L4 root within the psoas muscle but no muscle contractions were noted even if the current intensity was gradually increased up to 5 mA and the duration to 1 ms. The needle was removed and reinserted several times and the tip was readjusted without elicitation of any motor response to electrical nerve stimulation. A nerve stimulator dysfunction was suspected. The operator noticed that the displayed resistance was 0.4 KOhm and a short circuit was diagnosed (Video 1). Subsequent inspection revealed that the electrical connector had been introduced by force into the nerve stimulator, causing damage to the plug connections system (Figure 1) and causing the short circuit bypassing the main circuit of nerve stimulation. The nerve stimulator Stimuplex HNS12 and cable connector were replaced and quadriceps muscle contraction was elicited with a current intensity set at 0.4 mA confirming the correct position of the block needle adjacent to the lumbar plexus. After injection of 20

ml of ropivacaine 3.33 mg/ml, a solution spread was noted within the psoas compartment and the PLPB was successfully performed. Parasacral sciatic and cluneal nerve blocks had then been added to the PLPB allowing for the surgical repair of hip fracture.

Discussion of the technical report and algorithm

Combining ultrasound guidance and nerve stimulation may be helpful to safely confirm lumbar plexus sonoanatomy, and to place the tip of the needle just close to the targeted nerve. The dual guidance aims to decrease the incidence LAST and/or nerve injury, particularly while performing a deep nerve block such as a PLPB¹¹. A nerve stimulator malfunction or an electrical disconnection may occur during the nerve block procedure^{12,13}. The consequences for the patient can be multiple painful attempts or a serious complication such as nerve injury.

Failure in electrical nerve location may be related to a short circuit, misconnection or disconnection¹². The short circuit occurs when the cable or the electrode are in contact and leads to the direct channel of current from one to the other bypassing the patient. It is easy to detect short circuit if the NS is turn on before closing the circuit. The real current does not remain at 0 mA when the set current is increased. In this technical brief report, the problem has not been diagnosed because the nerve stimulator has been turned on after skin puncture (video). To ensure the absence of a short circuit, the user must turn on the stimulator before closing the circuit (i.e., before the needle passes the skin) and check that effective current remains at zero while the set current is increased. Only after excluding a short circuit, the set current must be adjusted and the skin penetrated. In our case report, the consequences have been more needle movements than expected and a delay before malfunction diagnosis (too low resistance). The resistance of the circuit is usually several KOhm due to skin resistance. A short circuit is difficult to diagnose because there is no warning signal of low resistance displayed by the nerve stimulator.

The two other most common causes of malfunction are the open circuit and improper skin-electrode contact. Recent nerve stimulators that display the real current during the procedure help in the diagnosis of improper electrode installation, disconnection or current failure. These devices have contributed to improve the safety of the procedure¹⁴. The circuit is open if it lacks a complete path between the positive and negative ends of the power source. The circuit is not closed, no current passes. The cause may be a dry electrode path, a

broken cable, or a disconnection. The diagnosis of an open circuit is easy with a device displaying the real delivered current. The real current displayed remains at zero when the set current is increased and the resistance is zero. If the external resistance is too high, the effective current is not zero but remains below the set current; it is a poor contact. The common cause is a dry electrode. The nerve location may be more difficult. The diagnosis is easy with modern nerve stimulators that display the real current and emit alarms in case of current failure if the physician is vigilant.

When an electrical failure is supposed, the anaesthetist should try to find the cause and resolve the problem (nerve stimulator, electrode cable, needle). The first step is to check the device, and this is described in the algorithm below with the HNS12 nerve stimulator. If the physician does not consistently check for an electrical failure with nerve stimulation, it could lead to severe adverse events.

Algorithm

1. *Apply skin electrode. Plug electrode cable into the stimulator and connect skin electrode. Plug electrode cable into the stimulation needle. Turn on the nerve stimulator according to the user manual. Check the self-test to confirm the equipment is ready for use (low battery..). Set the stimulus duration to 0.3-1 ms and the frequency to 1 or 2 Hz.*
2. *TEST 1: Increase the set current to 1.5-3 mA before inserting the needle into the skin (before closing the circuit). The effective current is expected to remain zero.*
 - *If the real current is higher than zero: presence of a short circuit; check the cables and the nerve stimulator.*
3. *TEST 2: Insert the needle into the skin and increase the set current: compare the set current with the effective current: both values must be identical.*
 - *If the real current is lower than the set current, the warning screen displays high resistance: presence of a poor contact (dry electrode and or dry skin).*
 - *If the real current remains at zero, and the resistance is zero: presence of an open circuit; check the connections, cables, and electrode.*

In conclusion, we described a new cause of short circuit during a dual guidance PLPB in this case report. The proposed algorithm may help to prevent such adverse event.

Figures legends

Figure 1: Image of a normal plug connection system (left side of the pic) and the damaged plug connection system (right side of the pic)

Video 1: Diagnostic of the short circuit and nerve stimulator malfunction.

References

1. Tran DQ, Salinas FV, Benzoni HT, Neal JM. Lower extremity regional anesthesia: essentials of our current understanding. *Reg Anesth Pain Med* 2019;44:143-180.
2. Joshi G, Gandhi K, Shah N, Gadsden J, Corman SL. Peripheral nerve blocks in the management of postoperative pain: challenges and opportunities. *J Clin Anesth* 2016;35:524-529.
3. de Leeuw MA, Zuurmond WWA, Perez RSGM. The Psoas Compartment Block for Hip Surgery: The Past, Present, and Future. *Anesth Res Pract* 2011;2011:1-6.
4. Capdevila X, Coimbra C, Choquet O. Approaches to the lumbar plexus: Success, risks, and outcome. *Reg Anesth Pain Med* 2005;30:150-162.
5. Strid JMC, Sauter AR, Ullensvang K, Andersen MN, Daugaard M, Bendtsen MAF, Søballe K, Pedersen EM, Børjglum J, Bendtsen TF. Ultrasound-guided lumbar plexus block in volunteers; a randomized controlled trial. *Br J Anaesth* 2017;118:430-438.
6. Sauter AR, Ullensvang K, Niemi G, et al. The Shamrock lumbar plexus block: A dose-finding study. *Eur J Anaesth* 2015;32:764-770.
7. Karmakar MK, Li JW, Kwok WH, Soh E, Hadzic A. Sonoanatomy relevant for lumbar plexus block in volunteers correlated with cross-sectional anatomic and magnetic resonance images. *Reg Anesth Pain Med* 2013;38:391-7.
8. Luedi MM, Upadek V, Vogt AP, Steinfeldt T, Eichenberger U, Sauter AR. A Swiss nationwide survey shows that dual guidance is the preferred approach for peripheral nerve blocks. *Sci Rep* 2019;9:9178.
9. Karmakar MK, Ho AM-H, Li X, Kwok WH, Tsang K, Ngan Kee WD. Ultrasound-guided lumbar plexus block through the acoustic window of the lumbar ultrasound trident. *Br J Anaesth* 2008;100:533-537.
10. Karmakar MK, Li JW, Kwok WH, Hadzic A. Ultrasound-Guided Lumbar Plexus Block Using a Transverse Scan Through the Lumbar Intertransverse Space: A Prospective Case Series. *Reg Anesth Pain Med*. 2015;40:75-81.
11. Zhang X, Li Y, He W, et al. Combined ultrasound and nerve stimulator-guided deep nerve block may decrease the rate of local anesthetics systemic toxicity: a randomized clinical trial. *BMC Anesth*. 2019;19.
12. Feugeas JL, Lacroix F, Choquet O, Capdevila X. Regional Anesthesia: Principles of Localization Using Electrical Stimulation. In Bissonnette B, editor. *Pediatric Anesthesia: Basic Principles, State of the Art, Future*. PMPH-USA 2011. pp 757-66

13. Choquet O, Feugeas JL, Capdevila X, Manelli JC. Défaut de circuit électrique et neurostimulation: cas cliniques et procédures de prévention. *Ann Fr Anesth Réanim.* 2007;26 :245-8
14. Jochum D, Iohom G, Diarra DP, Loughnane F, Dupre LJ, Bouaziz H. An objective assessment of nerve stimulators used for peripheral nerve blockade. *Anaesthesia.* 2006;61:557-564.

Figure 1

