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Comparison of subgluteal sciatic nerve block duration in type 2 diabetic and non-diabetic patients

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Editor's key points

- Animal models of diabetes show reduced onset and increased duration of peripheral nerve blocks.
- This study aimed to evaluate the difference in block properties between diabetic and non-diabetic patients.
- Using careful evaluation of sensory dysfunction, diabetic patients were found to have a prolonged duration of a sciatic nerve block.
- Further study of the mechanisms of this longer action in diabetic patients is needed.

Background. Although animal studies demonstrated delayed recovery after nerve block in laboratory models of diabetes, the duration of the action of sciatic nerve blocks clinically in patients with diabetes remains to be determined. We studied the duration of a sciatic nerve block in type 2 diabetic patients compared with non-diabetic patients.

Methods. We prospectively included consecutive patients aged 50–80 yr, with type 2 diabetes with minor nerve injury (confirmed with 5.07 at 10 g monofilament test, $n=23$) and non-diabetic patients ($n=49$) scheduled for distal lower limb surgery. Before surgery, a subgluteal sciatic nerve block (20 ml of ropivacaine 4.75 mg ml^{-1}) was performed with an ultrasound approach coupled with nerve stimulation. The primary endpoint was the sensory block duration.

Results. There was no significant difference between groups for age, but haemoglobin A1c and creatinine values were significantly higher in the diabetic group. There was no difference in 5.07 (10 g) monofilament testing, but the diabetic group had lower scores for the 0.4 and 0.07 g tests ($P<0.01$). There was no significant difference in the median onset time for the sensory block (25 *vs* 25 min, NS), but the median duration of the sensory block (21 *vs* 17 h, $P<0.01$) and the motor block (16 *vs* 12 h, $P<0.01$) were higher in the diabetic group. No complication occurred in either group.

Conclusions. These findings demonstrate that diabetic patients with pre-existing incipient neuropathy exhibit delayed recovery from the block with ropivacaine, confirming animal studies.

Clinical trial registration. ClinicalTrials.gov, NCT01704612.

Keywords: anaesthetic techniques, regional; local anaesthetics, ropivacaine; diabetes mellitus, type 2

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Over the past three decades, type 2 diabetic patients have more than doubled, making it one of the major healthcare challenges to all nations.[1] The anaesthetic management of these patients is more challenging because of more frequent difficulties in airway control, association with myocardial dysfunction, renal disease, and the occurrence of perioperative dysglycaemia.[1–6] For upper or lower limb surgery in diabetic patients, peripheral regional anaesthesia is an interesting alternative to general anaesthesia because it provides effective analgesia, may decrease haemodynamic complications, and reduce glycaemia dysregulation.[6–8] The fear of nerve injury after regional anaesthesia in diabetic patients is a concern that has neither been confirmed nor refuted by the current literature.[9–11] Diabetic patients with neuropathy may be considered at an increased risk because of the possibility for double crush syndrome when a chronic axon lesion related to diabetes is associated with an unexpected distal nerve injury related to regional anaesthesia.[9]

In streptozotocin-induced diabetic rats, nerve degeneration is associated with a loss of myelinated and unmyelinated fibres, paranodal demyelination, segmental degeneration, microvascular dysfunction (endothelial alteration), axonal Ca^{2+} dyshomoeostasis (i.e. Ca^{2+} currents), and mitochondrial dysfunction.[12–14] These diabetic rats demonstrated nerve conduction velocity alterations. Several studies observed a decrease in conduction velocity in the sciatic nerve after

perineural local anaesthetic (LA) agent administration.[15 16] In addition, diabetic rats exhibited axonal degeneration and demyelination of the sciatic nerve after administration of LA, which did not occur with saline. This is thought to be related to LA toxicity. However, the precise effects of regional anaesthesia in diabetic patients remain poorly described.[17 18] In diabetic patients, no clinical study clearly demonstrated any increased risk of nerve dysfunction or injury due to perineural LA agent injection or needle approach, while several case reports illustrated delay or absence of recovery from the block.[10 11 19] Why diabetes would delay recovery from the block is a controversial subject. One theory is that diabetes induces axonal degeneration.[20] Axonal degeneration is associated with alteration of nerve sensitivity to LA agents.[20] Another theory suggests that diabetes reduces the activity of potassium and sodium channels in the nerve fibres, influencing the threshold and the conduction velocity in these neurons.[12–14] Consequently, the onset time and the block duration after a peripheral nerve block may be modified in diabetic patients.

We undertook a prospective observational single-blinded study comparing a sciatic nerve block in type 2 diabetic and non-diabetic patients, hypothesizing that recovery from the block is delayed in diabetic patients.

Methods

Patients and group

This trial was a prospective observational study approved by the institutional human investigation committee [Comité de Protection des Personnes, Iles de France, Paris VI (CPP-73-11, Eudra CT 2011: A00737: 34)] and registered on ClinicalTrials.gov (NCT01704612). After checking eligibility criteria and obtaining written informed consent on the day before surgery, consecutive patients aged between 50 and 80 yr and undergoing elective surgery of the lower limb (knee, ankle, foot) were included between July 2011 and March 2012 in two French centres (APHP, La Pitié-Salpêtrière Paris, France; Hôpital Carémeau, Nîmes, France). Criteria for non-eligibility were as follows: refusal of a sciatic nerve block, age $<$50 or $>$80 yr, ASA status $>$IV, presence of contraindications to local anaesthesia (known allergy to LAs, sepsis), emergency surgery, patients unlikely to be fully cooperative during the study, psychiatric disorders, or abusing alcohol or drugs, and participation in another study within the previous 30 days. Moreover, patients with preoperative estimated values of creatinine clearance $<$50 ml min^{-1} (Cockroft and Gault formula) or with glycosylated haemoglobin (A1c) level $>$8% or with type 1 diabetes mellitus (insulin therapy) were not included. Other causes of neuropathy (such as familial, alcoholic, nutritional, and uraemic polyneuropathy) were excluded by a history and clinical evaluation.[19] Moreover, patients with diffuse neuropathy affecting the peripheral nerves, defined as diabetic sensorimotor polyneuropathy with 5.07 (10 g) monofilament test $<$4 (score: 0–8), were excluded (see the 'Monofilament test score' section).[21–25] Diabetic patients who were 'diet-controlled' only and those requiring insulin were excluded as study participants.

Patients were divided into two groups according to their diabetic status: type 2 diabetic (patients with elevated fasting plasma glucose levels currently receiving an oral hypoglycaemic agent) and non-diabetic patients (control).

Monofilament test score

Before operation, monofilament examination was performed bilaterally using a Semmes-Weinstein 10 g (size 5.07) monofilament (Biomedix ITM Laboratoires, Lyon, France) according to previous studies.[21–25] Briefly, the patient's eyes were closed and the monofilament was applied to a non-callused site on the foot (dorsal and plantar) using a smooth motion; the skin was touched, the monofilament was advanced perpendicularly to the skin surface and was bent for a full second and then lifted from the skin. This manoeuvre was repeated 4 times per foot in a random arrhythmic manner. The responses were tallied to produce a score ranging from 0 to 8 [normal (1 point assigned), decreased (0.5 point assigned) or absent (0 points assigned)]. A score of 0 represented a complete lack of perception, whereas a score of 8 represented full perception of all stimuli.[26] Moreover, monofilament 4 g (size 4.56), 2 g (size 4.3), 0.4 g (size 3.61), and 0.07 g (size 2.83) were tested in both groups to detect incipient neuropathy.[26]

Ultrasound subgluteal sciatic nerve block

All patients received oral hydroxyzine (100 mg) 1 h before surgery and were monitored (Sp_{O_2}, ECG, non-invasive arterial pressure); then venous access was secured.

In both groups, a sciatic nerve block was performed using ultrasound guidance plus peripheral nerve stimulation. Briefly, patients were placed in the ventral position. The ultrasound transducer (8–12 Hz, GE logiq E, GE Health Care Canada, Mississauga, Ont., Canada) was initially positioned on the skin, transversely in the popliteal region (tibial and fibular sciatic nerve identification). Then the probe was translated to subgluteal region with a continuous sciatic nerve short-axis view. In the subgluteal region, a 100 mm insulated needle (Stimuplex, B Braun, Melsungen, Germany) connected to a nerve stimulator (HNS 12, B Braun) was introduced. The needle was inserted parallel and in line with the ultrasound transducer and then advanced slowly under real-time ultrasound guidance until it was in close proximity to the nerve. The stimulating current was set initially at 2.0 mA (frequency, 1 Hz; time, 0.1 ms) to obtain a sciatic motor response (foot plantar flexion or extension). Then, the current ampage was slowly decreased and minimal effective ampage for motor response (tibial or fibular) was recorded. Then, an extraneural injection of ropivacaine (20 ml of 4.75 mg ml^{-1}, by mixing an equal amount of 2 and 7.5 mg ml^{-1} solutions) was performed around the sciatic nerve in both groups. If necessary, the needle tip was repositioned to produce a circumferential spread of the LAs around the nerve. All