The Electrophysiological Effect of Dextrose 5% in Water on Single-Shot Peripheral Nerve Stimulation

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When performing regional anesthesia, a small volume of local anesthetic or normal saline abolishes a motor response induced by a low current (0.5 mA). In this case series we describe the electrophysiological effect of a nonconducting (dextrose 5% in water, D5W) injectate on a motor response elicited by low current electrical stimulation. Twenty-nine peripheral nerve blocks were performed in 20 patients using insulated needles. Each needle was primed with D5W. The needle was advanced towards the target nerve until corresponding motor responses were observed using a current of 0.5 mA or less. Once the needle position was optimally placed, 1 mL of D5W was injected followed by a predetermined dose of local anesthetic. The effects of the injectates (D5W and local anesthetic) on the motor response were observed at all needle insertion sites. In all cases, the motor response was at least maintained or augmented (96%) immediately after the injection of D5W. All motor responses diminished after the injection of local anesthetic (100%). All blocks were considered clinically successful.

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During electrical stimulation, the ability to elicit a motor response with a low current (<0.5 mA) is lost after injection of even a small amount of normal saline or local anesthetic (Raj test) (1). In contrast, the injection of a nonconducting solution (dextrose 5% in water, D5W) has been demonstrated to maintain a motor response in a porcine model by decreasing the conductive surface area and increasing the current density at the needle tip (2). However, this phenomenon has not been demonstrated in a clinical setting. This case report describes the effect of the injection of a nonconducting solution (D5W) on a motor response elicited by electrical stimulation during peripheral nerve block.

Case Reports

After institutional ethics approval and informed consent, 29 peripheral needle insertion sites were performed in 20 patients (Table 1). A 22-gauge insulated needle (Stimuplex, B. Braun, Bethlehem, PA) was primed with D5W. The needle was inserted and advanced in a standard fashion with the patient under light sedation. At each insertion site, the stimulator was set at a current between 0.8 and 1 mA (0.1 ms; 1 Hz). As the needle advanced towards the target nerve, the current was gradually decreased until a motor response was obtained at a minimal current (≤0.5 mA). Subsequently, 1 mL of D5W was injected while firmly holding the needle in place. The motor response was visually graded as follows: no change, augmented, or diminished. To initiate the block, 10–20 mL of a local anesthetic mixture of lidocaine 1%–2% and 0.5% bupivacaine with 1:200,000 epinephrine in normal saline was then injected. Any change in the motor response upon the injection of local anesthetic was also noted. General anesthesia was induced after the onset of the block. A failed block was defined as the requirement for intraoperative or immediate postoperative (in the recovery room) IV opioid for pain control, as judged by the anesthesiologist.

In all cases, the motor responses were at least maintained or augmented (96%) immediately after the injection of D5W. All motor responses were abolished immediately after the injection of <1 mL of local anesthetic. There was no significant difference between the threshold currents at the different peripheral sites (Table 2). The injection of D5W and local anesthetic did not cause any pain in any of the patients studied. The onset of each block occurred within 10 min. All patients awoke comfortable and did not require intraoperative or postoperative opioids.

Discussion

This is the first clinical case series to describe the effect of the injection of a nonconducting solution (D5W) on a motor response elicited by low current electrical stimulation during peripheral nerve block. The injection of D5W maintained or augmented the elicited

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Table 1. Summary of the Electrophysiological Effect of Dextrose 5% in Water on Single-Shot Peripheral Nerve Stimulation

Patient no.	Block performed	Threshold current	Motor response after D5W	Motor response after local anesthetic
1	Femoral	0.22	Augmented	Disappeared
1	Sciatic	0.32	Augmented	Disappeared
2	Supraclavicular	0.4	Augmented	Disappeared
3	Interscalene	0.42	Augmented	Disappeared
4	Femoral	0.37	Augmented	Disappeared
5	Femoral	0.42	Augmented	Disappeared
5	Sciatic	0.38	Augmented	Disappeared
6	Femoral	0.52	Augmented	Disappeared
6	Sciatic	0.46	Augmented	Disappeared
7	Femoral	0.28	Augmented	Disappeared
7	Sciatic	0.52	Augmented	Disappeared
8	Femoral	0.57	Augmented	Disappeared
8	Sciatic	0.23	Augmented	Disappeared
9	Femoral	0.44	Augmented	Disappeared
9	Sciatic	0.35	Augmented	Disappeared
10	Femoral	0.47	Augmented	Disappeared
10	Sciatic	0.5	Augmented	Disappeared
11	Interscalene	0.32	Augmented	Disappeared
12	Interscalene	0.42	Augmented	Disappeared
13	Interscalene	0.46	Augmented	Disappeared
14	Interscalene	0.48	No change	Disappeared
15	Supraclavicular	0.1	Augmented	Disappeared
16	Femoral	0.25	Augmented	Disappeared
16	Sciatic	0.42	Augmented	Disappeared
17	Sciatic	0.25	Augmented	Disappeared
18	Sciatic	0.2	Augmented	Disappeared
19	Supraclavicular	0.38	Augmented	Disappeared
20	Lumbar plexus	0.42	Augmented	Disappeared
20	Sciatic	0.35	Augmented	Disappeared

D5W = dextrose 5% in water.

motor response whereas a subsequent injection of local anesthetic diminished the same motor response. This phenomenon was demonstrated for interscalene, supraclavicular, lumbar plexus, femoral, and sciatic nerve blocks.

The clinical findings observed in this case series are comparable with those of a previous study in a porcine model (2). The cause of the motor responses being maintained or even augmented after the injection of D5W (a nonconducting solution) is likely a result of a decreased conductive area and increased current density surrounding the stimulating needle tip. In contrast, the injection of local anesthetic (a conducting solution) after D5W abolished the muscle twitch by increasing the conductive surface area and decreasing the current density at the stimulating needle tip. This reduction in current density by conducting solutions is well known in other medical fields (3,4).

A limitation of this report is that it was not conducted in a double-blind manner. Ideally, an objective electromyelogram measurement should have been used to quantify each motor response. However, we chose to visually assess each motor response (no change, diminished, or augmented) to depict a clinical setting. D5W was selected because its osmolality is similar to that of normal saline (5–7), it is painless on injection as compared with sterile water (5–7), and it is not known to cause any long-term sequelae in animals or humans when injected around neurological tissue (8–11).

Table 2. Mean Threshold Current at Different Sites After Injecting 1 mL of Dextrose 5% in Water

Block	No. of patients	Mean threshold current (SD)
Supraclavicular	3	0.29 (0.16)
Interscalene	5	0.42 (0.06)
Sciatic	11	0.36 (0.11)
Femoral	9	0.39 (0.12)
Lumbar plexus	1	0.4 (N/A)

$P < 0.05$.

Clearly, the motor response elicited by electrical stimulation is sensitive to changes at the needle-tissue interface (i.e., electrical conduction interference from blood or interstitial fluid). This may partly explain why a motor response was not observed in up to 70% of patients after nerve stimulation with up to 1 mA in the brachial plexus after obtaining paresthesia (12,13) or verification of correct needle placement by ultrasound (14). From a clinical perspective, the injection of

nonconducting solutions may eliminate any possible electrical conduction interference from blood or interstitial fluid and minimize the incidence of false negative motor responses. In this study, all patients had positive motor responses without paresthesia. Anecdotally, we noticed that by priming the needle with D5W, the elicited motor responses were more stable and less affected by slight movement. Although this was not formally tested in this study, it supports the concept of using a nonconducting injectate to provide a uniform electrical field around the stimulating needle tip and a reproducible motor response. In addition, one may potentially use a nonconducting solution such as D5W instead of normal saline to dilate the perineural space during continuous peripheral block catheter placement to avoid the electrical conducting effect of normal saline and facilitate optimal catheter placement. Further studies in this area are warranted to justify these speculations.

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