The Supraclavicular Block with a Nerve Stimulator: To Decrease or Not to Decrease, That Is the Question

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Portable nerve stimulators for nerve blocks have been available for more than 40 yr. It is generally accepted that seeking a motor response at low outputs increases the chances of success. It is customary to start the procedure at a higher current with the goal of finding the nerve. After an adequate response is elicited, the current is decreased before the local anesthetic is injected. However, how low is low enough and, for that matter, how high is too high have not been adequately determined. Our experience seems to indicate that, in the supraclavicular block, the type of response obtained is as important as the output at which it is elicited, provided that this current is not higher than 1 mA. In this context, it is theoretically possible that our initial seeking current of 0.9 mA could be an adequate injection current if it is combined with an appropriate response. We designed this study to test the hypothesis that a response of the fingers in flexion or extension, elicited at 0.9 mA, could be followed immediately by the local anesthetic injection. We did not intend to compare 0.5 and 0.9 mA as minimum stimulating currents but rather as currents able to elicit an unmistakable motor twitch. Sixty patients were randomly assigned to one of two groups. Group 1 ($n = 30$) was injected with a motor twitch in the fingers that was still visible at 0.5 mA. Group 2 ($n = 30$) was injected after a similar response to that in Group 1 was elicited, but at the initial output of 0.9 mA, without any further decrease. The blocks were injected with 40 mL of local anesthetic solution. One patient was excluded from the study for failing to meet protocol criteria. The success rate in the remaining 59 patients was 100%; success was defined as complete sensory blockade at the median, ulnar, and radial nerve territories of the hand that was accomplished in ≤30 min from the time of injection and that did not require supplementation or general anesthesia. In fact, all blocks became complete within 22 min of the injection. The onset of anesthesia occurred in 10.9 ± 5.4 min in the 0.5-mA group and 11.4 ± 4.8 min in the 0.9-mA group; this difference was not statistically different. The onset of analgesia and the duration of anesthesia were also similar in both groups. There were no complications, and the respondents in both groups graded their experience at a similar level of satisfaction. We conclude that during the performance of a supraclavicular block eliciting a clearly visible response of the fingers at 0.9 mA can be immediately followed by the injection of local anesthetic, because decreasing the output to 0.5 mA does not seem to improve the overall quality of the block as measured by the onset and duration of anesthesia or patient satisfaction.

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When a nerve block is performed with a nerve stimulator, a muscle twitch obtained at low output indicates close proximity to the nerve, and this translates into better success rates (1). However, the question of how close is close enough has not been clearly defined in clinical practice, and it might be different for different blocks (2). This is particularly true in single-injection plexus anesthesia, in which more than one nerve is to be blocked starting from one point of injection.

During a nerve-stimulator technique, the initial current setting, or seeking current, is the result of a balance between a current high enough to provide some guidance into the nerve yet gentle enough to avoid a confusing and overly strong response. Once the desired response is elicited, both the nerve-stimulator output and the needle position are manipulated to reproduce the response at a lower current. The ability to inject a block at the same current at which the technique is started would be appealing because it would save time and avoid unnecessary and potentially dangerous needle manipulations.

We designed this study to test the hypothesis that injecting a supraclavicular block immediately after eliciting a clear response of the fingers in either flexion or extension at a current of 0.9 mA (our usual seeking

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current) would produce a similar quality of block to one injected at 0.5 mA.

Methods

IRB approval and informed consent were obtained. Every adult patient, ASA physical status I–III, who presented for surgery on the elbow, forearm, wrist, or hand was considered a candidate for this study. Exclusion criteria included pregnancy, diabetes, recent drug use (48 h), alcohol abuse, previous nerve damage, and psychiatric history, among others. The patients received a peripheral IV line, and standard ASA monitors were applied. Supplemental oxygen was given through a nasal cannula.

Before the technique was started, every patient was lightly sedated with midazolam 1 mg IV and fentanyl 50 μg IV. No additional sedation was allowed until the block success had been determined. The patients then were randomly assigned to one of two groups. The techniques in both groups were started with an initial seeking current of 0.9 mA at 1 Hz, as is our custom. A clearly visible twitch of all fingers, either in flexion or extension, was considered the only adequate response. Group 1 was injected after a motor twitch was still clearly visible at the reduced output of 0.5 mA. Group 2 was injected at the initial current of 0.9 mA after a similar twitch was elicited in the fingers, without decreasing the output. The quality of the response in terms of type, location, and subjective intensity was similar in both groups. It was not our intention to identify whether these two different currents were the minimum currents able to elicit a response in the fingers. Instead, the goal was to elicit an unmistakable motor twitch of the fingers.

Every patient received our customary supraclavicular block with a 22-gauge, 50-mm, short-bevel, insulated needle (Stimuplex; B. Braun, Bethlehem, PA) and a nerve stimulator (Stimuplex-DIG; B. Braun).

The nerve stimulator used for the study was new, and at the start of the study it was equipped with a fresh battery. It is our practice to replace the battery every 2 mo without waiting for the low-battery indicator to come on. The injection was performed incrementally in 5-mL aliquots with frequent aspirations. Every block was injected with 40 mL of a solution containing 1.5% mepivacaine, 0.2% tetracaine, 1:200,000 epinephrine, and 4 mL 8.4% sodium bicarbonate. After injection, an investigator blinded to the output selected for injection performed an assessment of sensory blockade by using pinprick. The palmar surfaces of the index and little finger were used to test the median and ulnar nerve territories, respectively, in the hand. The dorsal surface of the thumb was used to test the radial nerve. The end of the injection was considered Time 0. The sensory tests were conducted at 2, 4, 6, 8, 10, 15, and 20 min and every 2 min thereafter if necessary up to 30 min. For the purpose of this study, the sensory blockade had to become complete within ≤30 min to be considered successful.

Time to analgesia was defined as the time elapsed from the end of the injection to the first dull response to pinprick in any of the three sensory territories in the hand. Time to anesthesia was defined as the time between injection and the complete development of anesthesia (no sensation reported to pinprick) in all three sensory sites.

The patients were followed into the recovery room and then 24 h later were either visited or contacted by phone. Specific questions about any residual numbness, discomfort, and pain were asked. The patients were also asked to evaluate their experience as satisfactory, neutral, or unsatisfactory.

Results

Table 1 shows that both groups were statistically similar in terms of age, sex ratio, height, and weight. The onset of anesthesia took a mean of 10.9 min in Group 1 and 11.4 min in Group 2, a difference that is not statistically significant ($P < 0.05$). The onset of analgesia or first reported dull sensation in the hand took a mean of 2.1 min in Group 1 and 2.5 min in Group 2—again, not statistically different ($P < 0.05$). The duration of anesthesia was also similar in both groups. Of 60 patients enrolled in the study, 1 had to be excluded because of cocaine use within 24 h and accidental spillage of 10 mL of local anesthetic during injection. The success rate in the remaining 59 patients was 100%; success was defined as complete anesthesia to pinprick at the ulnar, median, and radial nerve territories of the hand that did not require supplementation or general anesthesia. Only 1 patient of the 59 who completed the study required more than 20 min (22 min) to develop complete anesthesia of the hand. This patient belonged to Group 1 (injected at 0.5 mA). The remaining 58 patients developed complete anesthesia in ≤20 min. The surgical incision in all cases occurred within 40 min from the end of the injection.

Forty blocks (66%) were completed by residents and 20 blocks (33%) by attending physicians. All 59 patients graded their experiences as either "satisfactory" or "neutral." No patient responded that the experience was "unsatisfactory." No complications were reported.

Discussion

We favor the use of a supraclavicular block (modified Winnie's approach) as the main anesthesia for any surgery on the upper extremity that does not involve the shoulder (3). The supraclavicular block is associated with a rapid onset and reliable anesthesia (4,5), and, in our institution, it has proven to be a safe technique as well (6). We always perform it with the help of a nerve stimulator.

Perthes in 1912 and Pearson in 1955 demonstrated that nerves could be identified by electrostimulation (7), but it was the work of Greenblatt and Denson (8) in 1962 that introduced the nerve stimulator into anesthesiology clinical practice. Nerve stimulators are now widely seen as useful aids in nerve blocks (1,9). During the 1980s, the characteristics of an ideal instrument were studied and defined (10–13). These and other studies have helped to establish the relationship between a motor response and the needle tip-nerve distance (1,9,14,15). Modern nerve stimulators have a digital readout and deliver current with different degrees of accuracy. The Braun Stimuplex-DIG used in this study seemed to perform adequately within the ranges most often used in clinical practice and certainly within the ranges used in this study (9,16).

Because the intensity of the current needed to produce a motor twitch is inversely proportional to the square of the needle tip-nerve distance (1), it seems reasonable to delay the injection until a motor response is elicited at low outputs. A few practitioners try to determine the exact current at which the motor twitch disappears (17), whereas most are satisfied with reaching a preestablished low threshold, and if a visible motor response is still present, they proceed with the injection without further delay (18–24). Although 0.5 mA seems to be a very popular number used to define low output, the fact is that "how low is low enough" remains undetermined, and it might well be different for different blocks (2,25,26). Single-injection plexus anesthesia makes this assessment more complex, because the local anesthetic must reach several nerves starting from a point determined by the proximity of the needle to only one of these nerves. In ideal conditions, the spread of an adequate volume of local anesthetic within the sheath surrounding a plexus should not depend on the point at which the sheath is penetrated. However, the many factors in play, both inside and outside the sheath, are not completely understood.

It has been our experience, as well as that of other authors (27,28), that in a supraclavicular approach, the type of response (identification of a specific nerve) and low output (proximity to that nerve) are both important factors that influence the overall success. The intimate relationship of the lower trunk to the subclavian artery, as shown in Figure 1, could be one reason why better results are obtained when a trunk other than the superior trunk is made the epicenter of the injection (28,29). Perhaps depositing the local anesthetic close to the lower trunk increases the chances of blocking it directly, overcoming the obstacle to diffusion that the closely located pulsatile artery might exert on this trunk. This remains speculative.

Table 1. Population Demographics and Results

Variable	Group 1 (0.5 mA)	Group 2 (0.9 mA)
Age (yr)	34 ± 12	34 ± 13
Sex (m/f)	22/7	22/8
Height (cm)	173 ± 10	174 ± 9
Weight (kg)	79 ± 13	82 ± 17
Analgesia onset (min)	2.1 ± 0.4	2.5 ± 1.3
Anesthesia onset (min)	10.9 ± 5.4	11.4 ± 4.8
Anesthesia duration (min)	266 ± 38	272 ± 44
Total	29	30

Values are expressed as mean ± SD.

It has been our practice to initiate the procedure with a current of 0.9 mA and begin the injection when the response elicited is still clearly visible at 0.5 mA. It is sometimes frustrating that after an acceptable response is found at the seeking current, this response is lost during the manipulations necessary to reproduce the response at lower outputs. It is difficult in some cases, and always time consuming, to elicit the same response once again.

Some time ago we noticed that the blocks we injected at 0.9 mA (e.g., the patient could not lie still) seemed to be as good as the blocks injected at lower currents. Thus, we wondered whether 0.9 mA was not too high of an injection current for a supraclavicular block. We set out to prove that hypothesis. We believe that the findings presented here prove us right. It is important to clarify that we did not try to determine whether the currents we used at injection were minimum currents, and most likely they were not. Instead, we were interested in eliciting an unmistakable motor twitch of the fingers. Thus, even though the subjective characteristics of the response at both outputs were deemed similar, it is possible that some or all of the twitches elicited at 0.9 mA could have still been present at 0.5 mA. This would be made irrelevant by the fact that in the supraclavicular block, a clear twitch of the fingers at 0.9 mA is all that seems to be needed to produce a successful block, as measured by the onset and duration of anesthesia.

Although determining the difference between 0.5 and 0.9 mA as minimum stimulating currents could be theoretically interesting, it does not match what we and many others do in clinical practice, which is to initiate the injection at a predetermined low output. Whether 0.5 and 0.9 mA, as minimum stimulating currents, are able to produce comparable results remains unclear.

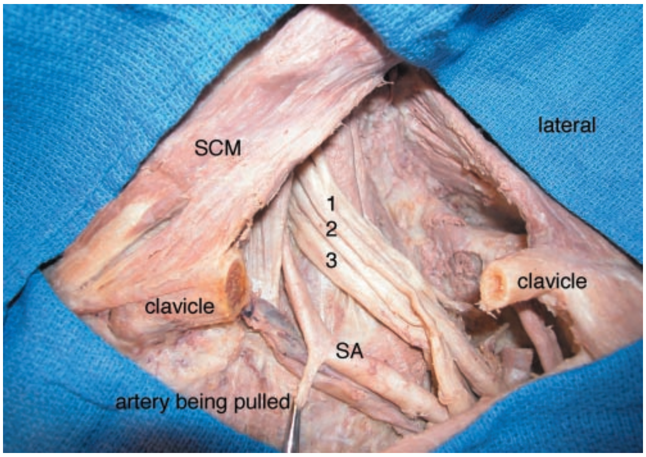

Figure 1. The subclavian artery and the brachial plexus. The subclavian artery is being pulled anteriorly and caudally to show the lower trunk, behind it. The connective tissue normally surrounding the plexus has been removed for clarity. SCM = sternocleidomastoid muscle; 1 = superior trunk; 2 = middle trunk; 3 = inferior trunk; SA = subclavian artery.

Injecting the block with the initial seeking current could save time, avoid unnecessary needle manipulations, and possibly make the operator rely less on outside help (30,31). It could also contribute to a decreased potential for nerve injury associated with excessive needle manipulations and the possibility of intraneural injection, which is possible when seeking a response at very low outputs (32–34).

In 2001, Carles et al. (2) demonstrated a clear relationship between output and success in the humeral canal. Even though these authors were interested in determining minimum stimulating currents and we were not, their results support the concept of using different currents at different locations. We understand that the particulars of every block make the results of our study applicable only to the supraclavicular technique. The sciatic nerve, with its thick perineurium, is an example of a situation in which currents lower than 0.9 mA would most likely increase the chances for success (35).

To determine the onset of analgesia and anesthesia, we performed our assessment at the sensory areas of the median, ulnar, and radial nerves in the hand. Even though the supraclavicular approach does not directly block the terminal branches of the brachial plexus, but rather its constituents, standardizing the sensory assessment for all patients to the development of anesthesia in the hand was considered adequate for comparison.

In conclusion, our findings suggest that a supraclavicular block can be injected at the initial seeking current if this is not higher than 0.9 mA and if the response elicited is a clear motor twitch of all fingers. These results apply only to the supraclavicular block performed under the conditions described.

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