Effect of needle size on success of transarterial axillary block

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The transarterial approach to brachial plexus block is a well-established method of producing anesthesia of the upper extremity. However, it is associated with a failure rate of 20% to 30%. Failure may be secondary to the common use of a relatively long needle, which can penetrate the posterior wall of the sheath and result in inadvertent injection of the local anesthetic into the surrounding tissue. The purpose of this investigation was to compare success rates following transarterial brachial plexus block with a standard 22-gauge, $1^{1}/_{2}$-in, B bevel needle or a 26-gauge, $^{1}/_{2}$-in needle.

We enrolled 98 subjects scheduled for elective surgery at or below the elbow and randomized them into 2 groups. The control group received a transarterial axillary block with a standard 22-gauge, $1^{1}/_{2}$-in, B bevel needle, and the experimental group received a transarterial axillary block with a 26-gauge, $^{1}/_{2}$-in needle. Success was defined as no discomfort at the time of incision. Success rates were compared using a χ^2 test, and a P value of less than .05 was considered significant. The overall success rate was significantly higher with the 26-gauge, $^{1}/_{2}$-in needle (42/48 [88%]) than with the 22-gauge, $1^{1}/_{2}$-in needle (39/49 [69%]); P = .035).

Key words: *Needle size, regional anesthesia, transarterial brachial plexus block, success rate.*

The transarterial approach to axillary brachial plexus block is a well-established method of producing regional anesthesia for surgeries at or below the elbow.[1-4] The transarterial approach is technically less difficult and reportedly results in a more reliable block compared with other approaches.[2-6] The reported failure rate of the transarterial approach, however, remains 20% to 30%.[2,3] It has been suggested in clinical trials that failure of the transarterial approach may be secondary to injection of the local anesthetic outside the neurovascular sheath.[2,3] Cockings et al[3] provided clinical evidence suggesting that failure of the brachial plexus block using the axillary transarterial approach is commonly due to advancement of the needle beyond the posterior wall of the neurovascular sheath. A 22-gauge, $1^{1}/_{2}$-in, B bevel needle frequently is used for transarterial brachial plexus block. The failure rate at our institution using a $1^{1}/_{2}$-in needle is similar to the 20% to 30% reported in the literature.

In 1961, DeJong[5] published a report describing the use of a 26-gauge, $^{1}/_{2}$-in needle for transarterial axillary brachial plexus block. DeJong suggested the shorter needle was of ample length to penetrate the neurovascular sheath but not long enough to pierce the posterior wall of the sheath, regardless of the size of the patient.[5] However, DeJong did not reveal whether the use of this shorter needle improved the success rate. A thorough review of the literature revealed no previous study had examined the success rate associated with the use of a short, small-caliber needle. The purpose of this study was to compare the success rates following transarterial brachial plexus block using a 26-gauge, $^{1}/_{2}$-in needle or a standard 22-gauge, $1^{1}/_{2}$-in, B bevel needle.

Materials and methods

The study was conducted in the main operating room of the Naval Medical Center, San Diego, Calif, following institutional review board approval. Informed

consent was obtained in the same-day surgery unit. Exclusion criteria included a history of the following: (1) seizure disorder, (2) vascular pathology, (3) coagulopathy, (4) preexisting neuropathy, (5) infection at the injection site, (6) limited range of motion in the surgical extremity, or (7) allergy to any study medication. Demographic information was obtained, and subjects were assigned randomly to an experimental group (26-gauge, $\frac{1}{2}$-in needle) or a control group (22-gauge, $1\frac{1}{2}$-in needle) using a random numbers table.

An 18-gauge, intravenous catheter was placed in the nonoperative arm, and an intravenous infusion of lactated Ringer's solution was initiated. Standard monitoring included noninvasive blood pressure measurement, continuous electrocardiography, and pulse oximetry. Subjects were premedicated with 1 to 2 mg of midazolam and 50 to 100 µg of fentanyl intravenously and positioned supine with the operative arm abducted and the elbow flexed to 90°. The subjects assigned to the experimental group received a transarterial brachial plexus block with a 26-gauge, $\frac{1}{2}$-in needle, and those assigned to the control group received a transarterial brachial plexus block with a 22-gauge, $1\frac{1}{2}$-in, B bevel needle (Figure). Due to the obvious difference in needle length, it was impossible to blind the individual administering the block to the group assignment. However, the anesthesia provider evaluating the block was blind to needle size.

The procedure for administering the block was standardized as follows: The assigned needle was attached to an extension tubing and syringe containing a 40-mL mixture of 1% mepivicaine and 0.2% tetracaine with 1:200,000 epinephrine. The axilla was prepped with povidone iodine in an aseptic manner. The axillary artery was identified by palpation as proximal as possible within the axilla, and an intradermal wheal was placed over the artery with 1 mL of 1% lidocaine. The assigned needle was inserted through the intradermal wheal in the direction of the artery until bright red blood was aspirated and then further advanced through the artery until blood ceased to be aspirated. Then, 40 mL of the local anesthetic mixture was injected posterior to the artery while maintaining digital pressure distal to the needle entry point and aspirating after each 5-mL injection. The needle then was withdrawn, direct pressure applied to the artery, and the arm immediately adducted. Direct arterial pressure was maintained for 5 minutes.

Data collection included the following: (1) patient demographics, (2) time to perform the block, (3) onset of sensory and motor block, (4) need for supplementation with local anesthetic, (5) blockade success, and (6) immediate and delayed complications.

Figure. Comparison of needle length and caliber

26-gauge, $\frac{1}{2}$-in needle   22-gauge, $1\frac{1}{2}$-in needle
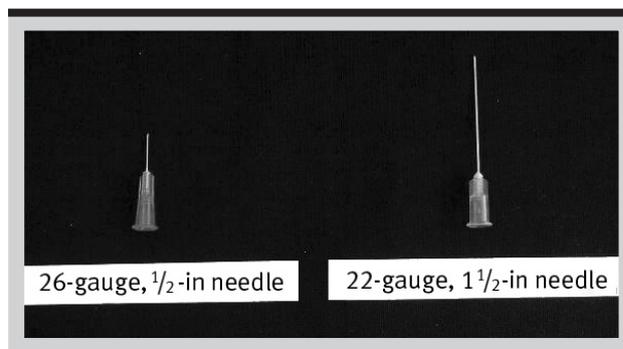
Time to perform the block was defined as the time from first needle insertion into the skin until the needle was removed, rounded to the nearest minute.

Onset of sensory block was evaluated in the median, radial, ulnar, and musculocutaneous nerves. Loss of sensation was assessed with a Semmes-Weinstein monofilament device,[7] which permits application of a monofilament thread to the skin at a fixed pressure of 279.4 g of force. Motor function was assessed using a modified Bromage Scale for the upper extremity.[8] Scoring for the Bromage Scale was as follows: 0, presence of complete motor function; 1, inability to extend the arm for 2 seconds; 2, inability to extend the arm or flex the forearm; and 3, inability to extend the arm, flex the forearm, or move the fingers. Sensory and motor functions were evaluated at 5-minute intervals for a period of 30 minutes. Blocks were evaluated again in the operating room at the time of surgical incision and were determined to be satisfactory, requiring supplementation, or failed. A *satisfactory* (successful) block was defined as a block that did not require supplementation with local anesthetic at the time of surgical incision.

Complications were categorized as immediate or delayed. *Immediate complications* were defined as the occurrence of hematoma or evidence of local anesthetic toxic effects at the time of block administration. *Delayed complications* were defined as the presence of hematoma, infection, paresthesia, or motor deficit at 1 week postoperatively.

Demographic variables were compared using descriptive statistics. Onset of sensory and motor block, success rate, and supplementation requirement were analyzed using a χ^2 test. Time to perform the block, rounded to whole minutes, was analyzed with a Mann-Whitney U test. A P value of less than .05 was considered significant. The performance of a power analysis with 20% attrition resulted in a sample size of 98 subjects.

Results

We enrolled 98 outpatients undergoing elective surgery at or below the elbow. The patients were 72 men and 26 women. One subject was disenrolled due to a protocol violation, resulting in data analysis for 97 subjects.

All subjects were classified according to the ASA physical status classification as class I (no systemic disease) or class II (mild systemic disease). No significant differences in demographic variables were noted between groups (Table). The median time to perform the block was 5 minutes in the control group (22-gauge, 1½-in needle) and 4 minutes in the experimental group (26-gauge, ½-in needle). Loss of sensation and motor function were evaluated at 5-minute intervals during a 30-minute period. There were no significant differences between the groups in time to loss of sensation or motor function in the median, radial, ulnar, or musculocutaneous nerve distributions at any of the time intervals examined. However, a statistically significant difference was found between groups in overall success rate.

A total of 42 (88%) of 49 blocks in the experimental group were determined to be successful compared with 39 (69%) of 49 in the control group (P = .035). In addition, 3 (8%) of the 39 patients with successful blocks in the control group required supplementation with local anesthetic during the surgery, while no subject in the successful experimental group required supplementation. This difference, however, did not reach statistical significance (P = .117).

Discussion

The results of this study suggest that use of a 26-gauge, ½-in needle increases the success rate of transarterial brachial plexus block. The nearly 70% success rate associated with the use of a standard 22-gauge, 1½-in needle in this study was consistent with previously reported data.[2,3] However, the success rate using the 26-gauge, ½-in needle (42/28 [88%]) was higher than previously reported.[2,3] No subject in the short-needle group required supplemental local anesthetic injection during the surgery while 8% (3/39) of the standard needle group did. This finding may be of clinical significance because a previous study of 1,000 consecutive subjects receiving a transarterial brachial plexus block attributed the only 2 sensory paresthesias that occurred to supplementation of incomplete blocks.[9]

No separate injection into the coracobrachialis muscle was required to block the musculocutaneous nerve in the experimental or the control group. This is consistent with the work of Winnie et al,[10] who concluded that the application of firm, digital pressure distal to the injection site and immediate, full

Table. Demographics of 97 patients undergoing transarterial axillary block*

	Control group (22-gauge, 1½-in needle)	Experimental group (26-gauge, ½-in needle)
Age (y)	30.6 ± 11.2	31.9 ± 12.2
Height (cm)	175 ± 9.22	172.77 ± 14.83
Weight (kg)	82.54 ± 14.16	80.24 ± 21.09

* Data are given as mean ± SD. The control group included 39 men and 10 women; the experimental group, 33 men and 15 women.

adduction of the arm promote optimal cephalad spread of the local anesthetic.

No immediate or delayed complications occurred in either group. This finding confirms previous findings of overall safety of transarterial brachial plexus block.[2-6] The sharper tip and the small diameter of the 26-gauge needle make the intentional piercing of the axillary artery seemingly less consequential than the standard 22-gauge, blunt-tipped needle.[5] In addition, the likelihood of damaging a nerve with such a small needle seems minimal.[5]

An interesting observation made in this investigation was that most of the successful blocks in either group had set up within 15 minutes of injection. Well-established blocks were achieved within the first 15 minutes of injection in 33 (79%) of 42 successful blocks in the experimental group and in 27 (69%) of 39 successful blocks in the control group. This implies that if a block has not begun to set up within 15 minutes, and an intermediate-acting local anesthetic such as mepivacaine was used, supplementation or an alternative anesthetic plan should be considered.

Multiple studies have demonstrated distinct advantages of regional anesthesia over general anesthesia.[11] These include retention of airway reflexes, decreased postoperative pain, and decreased incidence of nausea. The additional benefits of using a short, small-caliber needle when performing the transarterial technique include a higher success rate and the potential to avoid the increased time and risk involved with supplementing a patchy block or implementing an alternative anesthetic plan should the block fail.

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