Anesthesiology
66:814–816, 1987

A Comparison of Three Methods of Axillary Approach to Brachial Plexus Blockade for Upper Extremity Surgery

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Many variations of the axillary approach to blockade of the brachial plexus have been described. These include: transarterial fixation,[1] elicitation of a peripheral paresthesia,[2] and, most recently, the use of a peripheral nerve stimulator (PNS) to elicit a twitch.[3–9] There are no studies which compare, in a large scale prospective manner, these three methods of brachial plexus blockade. We, therefore, compared the results obtained when the axillary approach to brachial plexus blockade is attempted utilizing either transarterial fixation, a single paresthesia, or peripheral nerve stimulation.

METHODS

Fifty-nine consenting ASA Class I-III patients age 18 yr or more, scheduled for upper extremity surgery amendable to brachial plexus blockade, were studied with institutional review board approval. First- or second-year anesthesiology residents (range of training 1–19 months) supervised by a staff anesthesiologist administered all blocks. Three methods of blockade were randomly selected. In group 1, blockade was performed by transarterial fixation with one-half the dose of local anesthetic administered posterior to the axillary artery and one-half administered anterior. In group 2, we elicited a single paresthesia to the hand with injection of the total volume of local anesthetic at this point. For the third method, we utilized a PNS** with a 23-gauge, 1½-inch insulated needle. A current of 3 milliamps was slowly reduced to the lowest level below 1 milliamp that would elicit muscle activity in the hand. Three milliliters of local anesthetic was injected, and the current increased to the maximum. If maximum stimulation no longer produced muscle activity, the entire volume was injected. All three methods utilized an immobile needle technique,[10] and the blocks in groups 1 and 2 were performed with a 22-gauge short-bevel needle. Local anesthetic used was 40 ml/70 kg of 1.5% mepivacaine. We did not make a separate injection in an attempt to block the musculocutaneous nerve distribution. We considered blockade successful when the patient felt no pain in all four nerve distributions when tested by a surgeon (with an allis clamp) unaware of the method utilized. Patients were compared for any difference in height, weight, dose administered, sex, time from initiation of block to evaluation, supplementation required, and the nerve distribution missed. Statistical analysis consisted of two-tailed Fisher's exact probability test and multivariate analysis of variance followed by Duncan's multiple range test. A P value of less than 0.05 was considered statistically significant.

This Clinical Report is accompanied by an editorial. Please see: Selander D: Axillary plexus block: Paresthetic or perivascular. ANESTHESIOLOGY 66:726–728, 1987.

RESULTS

There was no significant difference between the three groups in age, height, weight, sex, and dose administered. The success rate of the block was not significantly different between the three groups (table 1). The ulnar and median nerves were most often missed; however, this was not statistically different than the radial nerve (table 2). There was also no difference seen in the need for supplementation of the block with local infiltration, as well as the level of training of the residents who performed the blocks, which ranged from 1–19 months (table 1). Ninety-five percent of the blocks were supervised by one attend-

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Received from Thomas Jefferson University Hospital, Department of Anesthesiology, 111 S. 11th Street-Suite 6275, Philadelphia, Pennsylvania 19107. Accepted for publication February 4, 1987. Presented in part at the Annual Meeting of the American Society of Anesthesiologists, Las Vegas, Nevada, October, 1986.

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Key words: Anesthetic techniques: axillary; brachial plexus; regional.

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ing anesthesiologist (Michael E. Goldberg, M.D.), with the rest supervised by two other attending anesthesiologists with equal distribution in all groups. All procedures performed were at the wrist level or distal. These included: 20 cases of carpal tunnel repair/median nerve release, 13 cases of Dupuytren's contracture release, 11 cases of arthroplasty of interphalangeal joint, six cases of ganglion excision, five cases of distal radial and/or ulnar plating, two cases of foreign body excision, and two cases which can be classified as miscellaneous finger operations.

The surgeons were consulted to determine if there were any complications related to the anesthetic, since these patients are followed closely in the Hand Clinic. The surgeons stated that they were unable to attribute any post-surgical problem to the anesthetic technique.

TABLE 1. Patient Variables and Success Rates for the Three Groups

	Group 1 (n = 19), Transarterial	Group 2 (n = 20), Single Paresthesia	Group 3 (n = 20), Nerve Stimulation
Age (yr)	56.3 ± 14.6	50.3 ± 17.0	44.9 ± 15.3
Weight (kg)	68.6 ± 11.4	68.7 ± 1.8	67.4 ± 11.9
Dose (ml)	39.2 ± 6.5	40.1 ± 6.6	38.7 ± 7.0
Success	15/19 = 79%	16/20 = 80%	14/20 = 70%
Training level (months)	7.9 ± 5.9	9.5 ± 5.8	7.0 ± 5.7
Training level (months) range	1-19	3-19	1-19

TABLE 2. The Incidence of Unblocked Nerves Following an Axillary Blockade

Nerve Missed	Group 1: Transarterial	Group 2: Single Paresthesia	Group 3: Nerve Stimulator	Total
Ulnar	2/19	3/20	3/20	8/59
Radial	1/19	3/20	2/20	6/59
Median	3/19	1/20	4/20	8/59
Musculoskeletal	0/19	0/20	0/20	

DISCUSSION

The axillary approach to brachial plexus blockade is a useful method of providing anesthesia for surgery of the hand and forearm. Many techniques have been described, including transarterial fixation and elicitation of a paresthesia or twitch in the hand.[1-9] The technique of transarterial fixation and elicitation of paresthesia have associated theoretical complications. Development of a hematoma after arterial puncture is possible,[10] and might produce ischemic damage to the brachial plexus. Injection of medication into the nerve is also possible when paresthesia is elicited if injection is undertaken during the paresthesia.[12] Use of the peripheral nerve stimulator might avoid these problems, in that no arterial puncture is required, and actual placement of the needle tip into the nerve is probably avoided. The peripheral nerve stimulator might also be useful in the anesthetized or uncooperative patient.

Several authors conclude a PNS was a good method for localization and blockade without discomfort. In a small series, Magora *et al.*[7] compared obturator blocks by fluoroscopy or PNS, and determined that nerve stimulation appeared to be more accurate. Smith,[8] studying interscalene blocks performed by anesthesiology residents, had a success rate of 47% with either PNS or paresthesia. He concluded that a PNS was not useful. McClain,[13] also using residents to perform interscalene blocks, had a 70-80% success rate with both PNS and paresthesia. There are no large-scale randomized prospective studies that address the use of the peripheral nerve stimulator to the axillary approach of the brachial plexus.

We found that a PNS can be utilized to establish blockade of the upper extremity, but the success rate is not different than other methods. Our ability to obtain blockade with the peripheral nerve stimulator (success rate 70-80%) may have been better than Smith's because we used a variable output device with 1 Hz pulse and maximum output of three milliamps. These are characteristics found to be desirable when selecting a stimulator to perform blocks.[14] Furthermore, we used an insulated needle which allows generation of current at the point[15] and avoids stimulation from contact with the shaft of the needle.[16]

In our series, the radial and musculocutaneous nerve distributions were not the ones most often missed, as is stated;[1] rather, all distributions were missed equally. This includes an unusually low incidence of failure to block the musculocutaneous distribution. Our results would agree with Thompson and Rorie's[17] findings of multiple septation in the brachial plexus sheath, since all 59 of the patients had at least one of the four distributions anesthetized. Perhaps a fourth experimental group utilizing elicitation of twitch or paresthesia over each nerve distribution would have been more successful. These rates are low, but appropriate for blocks established by first- or second-year residents.

In conclusion, the peripheral nerve stimulator is useful; however, it is no better than transarterial fixation or single paresthesia elicitation to establish blockade of the upper extremity *via* the axillary approach in the hands of anesthesia residents.

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Anesthesiology
66:816–819, 1987

Precordial Ultrasonic Monitoring during Cesarean Delivery

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Venous air embolism occurs during a wide variety of surgical procedures. Recently, a massive air embolism necessitating cardiopulmonary resuscitation was reported during cesarean delivery.[1] The purpose of this study was to investigate the complaints of chest pain and dyspnea frequently reported by parturients during cesarean delivery and to find a possible cause. Such chest pain is ascribed to many etiologies. In our experience, it is dismissed as secondary to surgical traction on the peritoneum or intraperitoneal structures (*e.g.*, the uterus). We believe that this chest pain could be secondary to venous air embolism; specifically, air entrained in venous sinuses opened during hysterotomy and subsequent delivery of the fetus and placenta. In this study, we used a precordial ultrasonic Doppler monitor to detect intracardiac air.[2]

METHODS AND MATERIALS

Eighty-nine ASA Class I patients who sequentially presented for elective cesarean delivery and had indicated a preference for either epidural or spinal anesthesia were selected for study. Informed consent was not obtained, nor judged to be necessary, since the ultrasonic Doppler is a common intraoperative monitor.

All parturients were hydrated according to a protocol of administering 1½ to 2 l of lactated Ringer's solution during the 15–30 min immediately before the induction of regional anesthesia.[3] A Travenol solution administration set (2 C0649) with a 50 ml in-line hand pressure pump (air trap) was used to ensure that no air was accidently infused intravascularly. Spinal anesthesia was induced in the right lateral decubitus position using a 26-gauge needle and hyperbaric 5% licocaine or a 1% tetracaine/10% procaine mixture of local anesthetic.[4] Alternatively, continuous lumbar epidural anesthesia was induced in the following manner: after identifying the epidural space at L_2/L_3 or L_3/L_4 with a 17-gauge Weiss needle, a test dose of 3 ml of 2% lidocaine with 1:200,000 epinephrine was administered, and a 23-gauge catheter

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Received from the Department of Anaesthesia, Brigham and Women's Hospital, Harvard Medical School, 75 Francis Street, Boston, Massachusetts. Accepted for publication December 2, 1986. Part of this work was presented as an abstract at the 1985 Annual Meeting of the American Society of Anesthesiologists.

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Key words: Anesthesia: obstetrics. Embolism: air. Monitoring: Doppler ultrasound.