Anesthesiology
77:1230–1231, 1992

Regional Anesthesia for Arteriovenous Fistula Creation in the Forearm: A New Approach

STEPHEN J. ELDREDGE, M.D.,* RICHARD J. SPERRY, M.D.,† JOEL O. JOHNSON, M.D., PH.D.‡

A common site for the creation of an arteriovenous fistula is the ventral aspect of the forearm. Sensory innervation of the cutaneous and subcutaneous tissues of the ventral aspect of the forearm is supplied by the lateral antebrachial cutaneous (musculocutaneous) nerve and the medial antebrachial cutaneous nerve.[1]

The musculocutaneous nerve arises from the lateral cord of the brachial plexus and is composed of fibers from the fifth and sixth cervical roots. It first lies lateral to the axillary artery, then pierces the coracobrachialis muscle and continues distally between the biceps and brachialis muscles. The motor branches supply the coracobrachialis, biceps, and brachialis muscles. The sensory branch supplies the anterolateral surface of the forearm.

The medial antebrachial cutaneous nerve arises from the medial cord of the brachial plexus and is composed of fibers from the eighth cervical and first thoracic spinal roots. This nerve travels subcutaneously along the medial aspect of the arm and supplies sensation to the medial surface of the forearm.

Anesthesia for arteriovenous fistula creation is frequently produced by either local anesthetic infiltration, general anesthesia, or brachial plexus block.[2] However, each of these anesthetic techniques may be less than optimum for any given patient. We, therefore, describe an alternative technique to produce regional anesthesia of the ventral aspect of the forearm by selectively anesthetizing the musculocutaneous and medial antebrachial cutaneous nerves.

CASE REPORT

Four ASA physical status III patients, ages 50–81 yr, received the following local anesthetic injections prior to the surgical creation of a forearm arteriovenous fistula:

The musculocutaneous nerve was anesthetized by depositing 5–7 ml of a local anesthetic mixture (0.5% bupivacaine and 2% lidocaine, 1:1) in the proximal coracobrachialis muscle, lateral and deep to the axillary sheath (fig. 1). The medial antebrachial cutaneous nerve was anesthetized by depositing an additional 10–12 ml of local anesthetic subcutaneously as a half-ring on the medial aspect of the arm, approximately one-half to two-thirds the distance from the shoulder to the elbow.

All patients were monitored with a continuous electrocardiograph, pulse oximeter, and noninvasive blood pressure cuff. Oxygen was administered through a nasal cannula. Following the administration of the local anesthetic, all patients had cutaneous anesthesia in the distribution of the lateral antebrachial cutaneous and the medial antebrachial cutaneous nerves. A mild degree of sedation was achieved by administering 1–2 mg midazolam and/or 50–100 μg fentanyl. The surgeons then created the arteriovenous fistula, which included subcutaneous tunneling of the vascular graft material. Additional local anesthetic infiltration by the surgeon was performed in one patient when the surgical excision extended laterally into the radial nerve distribution near the antecubital fossa. No additional analgesic or anesthetic was administered by the anesthesiologist. Except for the patient with surgical extension into the distribution of the radial nerve, no patient experienced discomfort during the surgical procedure. Additionally, no postoperative sequelae were noted.

DISCUSSION

Patients who are in need of a surgically created arteriovenous fistula often present challenges to the anesthesiologist. Besides presenting as outpatients, renal failure patients may have anemia, diabetes, and/or cardiopulmonary disease. This complex mix of medical diseases may make general anesthesia an undesirable alternative. Therefore, either regional anesthesia or local anesthesia is the best option for anesthetizing some patients.

The use of local anesthetics must be undertaken with knowledge of the pharmacology of these agents in the context of renal failure. Bupivacaine and lidocaine used in brachial plexus anesthesia alone or with epinephrine are associated with a 40% reduction in duration of analgesia in patients with renal failure.[3] This reduction has been attributed to a hyperdynamic cardiovascular system secondary to chronic anemia combined with increased elimination due to acidosis. These factors must be assumed to operate with both regional and local techniques. In addition, the acidosis and hyperkalemia seen in patients with chronic renal failure may increase the myocardial susceptibility to bupivacaine toxicity.[4] Hypoventilation secondary to coadministration of sedatives and opioids may further worsen the acidosis, thus increasing the unbound bupivacaine concentrations and the risk of toxicity.[5] To make matters worse, latency to onset of analgesia is unchanged in renal failure.

Local anesthetic infiltration by the surgeon is the anesthetic of choice in our institution. Local infiltration is often supplemented with conscious sedation and monitored anesthesia care, as these patients are often appre-

* Resident, Department of Anesthesiology.
† Assistant Professor, Department of Anesthesiology.
‡ Instructor, Department of Anesthesiology.
Received from the Department of Anesthesiology, University of Utah, and the Veterans Administration Hospital, Salt Lake City, UT.
Accepted for publication August 19, 1992.
Address reprint requests to Dr. Sperry: Assistant Professor, Department of Anesthesiology, University of Utah, 50 North Medical Drive, Salt Lake City, Utah 84132.
Key words: Anesthetic techniques, regional: brachial plexus block; infiltration. Kidney: renal failure.

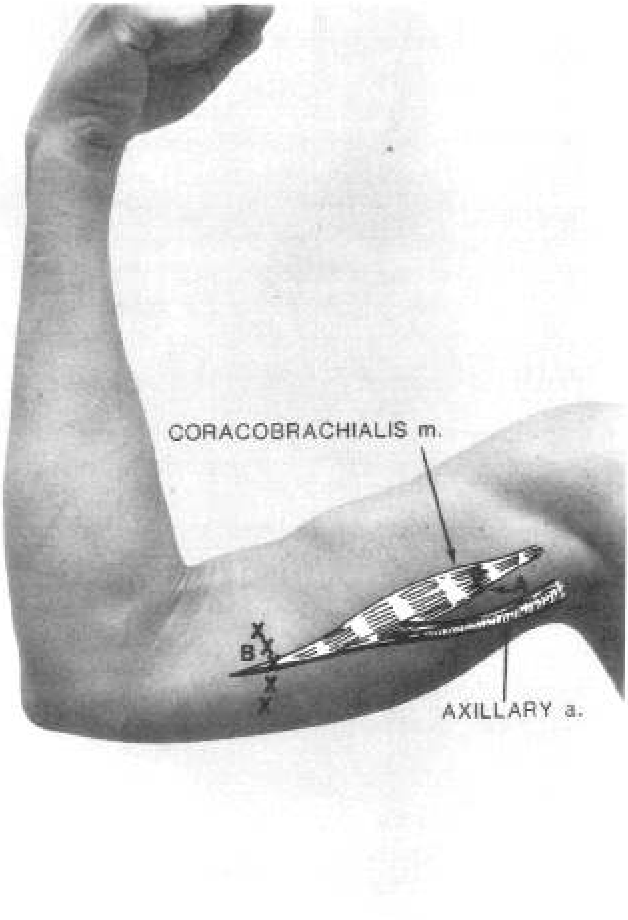

FIG. 1. *A:* Anesthesia of the musculocutaneous nerve is achieved by injecting 5–7 ml of local anesthetic into the proximal coracobrachialis muscle. *B:* Anesthesia of the medial antebrachial cutaneous nerve is achieved by injecting 10–12 ml of local anesthetic subcutaneously in a half ring on the medial arm.

hensive. However, the local infiltration often produces only marginal control of the surgical pain. This is particularly so when the heat from the electrical cautery is detected, and when the surgeon subcutaneously tunnels the vascular graft. As a result, some form of injectable anesthetic or analgesic is often administered to the patient and the conscious sedation may become unconscious sedation with its attendant risks of hypoventilation and inability to protect the airway. Additionally, the surgical field is often distorted by the infiltrated local anesthetic.

Although satisfactory regional anesthesia for this surgical procedure can be achieved with a brachial plexus block,[2] occasionally such a block is refused by the patient or is difficult to establish. The brachial plexus may be blocked using at least four different techniques: interscalene, supraclavicular, subclavian, and axillary. The approach used depends on the site of operation.[6] The supraclavicular and subclavian approaches are appropriate for arteriovenous fistulae in the antecubital region, whereas the axillary block usually requires additional anesthesia of the musculocutaneous nerve. Complications of the supraclavicular and subclavian approaches to the brachial plexus include the risk of pneumothorax (0.6–6%), brachial plexus injury (0.36%), and rarely, hemothorax or other hemorrhagic injuries.[7] Axillary approaches have been associated with nerve injury (0.4–5.5%)[7] and case reports of disruption of arterial flow,[8,9] pseudoaneurysm formation,[10] and intravascular injection.[11] The risk of blood flow complications secondary to vascular injury proximal to the arteriovenous fistula is a major concern for the vascular surgeon. In contrast, injection of local anesthetics to block peripheral nerves has not been associated with vascular complications (although hematomas occur), and nerve injury due to direct damage or toxicity is rare.[6]

By using 17–22 ml of a local anesthetic solution as described, the cutaneous and subcutaneous area involved in the creation of many forearm arteriovenous fistulae can be adequately anesthetized. This procedure is relatively simple and fast and bypasses the risk of arterial puncture and eliminates the need for high doses of local anesthetics. With this procedure, sedative and anxiolytic medications may be used sparingly without the need to augment the local anesthetic. Thus, time to complete recovery and discharge as outpatients may be decreased.

This procedure was well received by both patients and surgeons. We therefore recommend it as a technique for providing anesthesia for the surgical creation of an arteriovenous fistula in the forearm.

REFERENCES

1. Chusid JG: Correlative Neuroanatomy and Functional Neurology. Los Altos, Lange Medical Publications, 1979, pp 205–206
2. Moquet C, Bitker MO, Bailliart O, Rottembourg J, Clergue F, Montejo LS, Martineaud JP, Viars P: Anesthesia for creation of a forearm fistula in patients with endstage renal failure. ANESTHESIOLOGY 70:909–914, 1989
3. Bromage PR, Gertel M: Brachial plexus anesthesia in chronic renal failure. ANESTHESIOLOGY 36:488–493, 1972
4. Gould DB, Aldrete JA: Bupivacaine cardiotoxicity in a patient with renal failure. Acta Anaesthesiol Scand 27:18–21, 1983
5. Burney RG, DiFazio CA, Foster JA: Effects of pH on protein binding of lidocaine. Anesth Analg 57:478–480, 1978
6. Lanz E, Theiss D, Jankovic D: The extent of blockade following various techniques of brachial plexus block. Anesth Analg 62: 55–58, 1983
7. Abram SE, Hogan QH: Complications of nerve blocks, Anesthesia and Perioperative Complications. Edited by Benumof JL, Saidman LJ. St. Louis, Mosby Year Book, 1992, pp 52–76
8. Ott B, Neuberger L, Frey HP: Obliteration of the axillary artery after axillary block. Anaesthesia 44:773–774, 1989
9. Merrill DG, Brodsky JB, Hentz RV: Vascular insufficiency following axillary block of the brachial plexus. Anesth Analg 60:162–164, 1981
10. Groh GI, Gainor BJ, Jeffries JT, Brown M, Eggers GWN: Pseudoaneurysm of the axillary artery with median-nerve deficit after axillary block anesthesia. J Bone Joint Surg 72:1407–1408, 1990
11. Greene ER: Intravascular injection of local anesthetic after venipuncture of the axillary vein during attempted brachial plexus block. Anesth Analg 65:421–422, 1986