Modified Axillary Block

With Block of the Lateral Antebrachial Cutaneous (Terminal Musculocutaneous) Nerve

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Since the median, ulnar, and radial nerves lie in close proximity to the axillary artery in the neurovascular compartment of the axilla, all three nerves are easily and completely blocked by the axillary approach with injection of a moderate volume of anesthetic.

Because of its more proximal origin, however, complete motor and sensory block of the musculocutaneous nerve can be obtained only by the injection of a relatively large volume of local anesthetic into the axillary neurovascular compartment. Block of the distal sensory portion of the musculocutaneous nerve—the lateral antebrachial cutaneous nerve—insures effective analgesia of the lateral forearm, wrist, and hand with a smaller volume and thus a lower total dosage of local anesthetic.

Modified axillary block, providing motor and sensory block of the median, ulnar, and radial nerves and sensory anesthesia of the lateral antebrachial cutaneous nerve, consists of an injection of a moderate volume of anesthetic at the axilla, digital or other compression of the neurovascular compartment distal to the injection site, and a supplementary injection of the lateral antebrachial cutaneous nerve as it emerges from the lateral cleft between the biceps and brachialis muscles at the elbow.

BLOCK of the brachial plexus via the axillary approach has been accepted widely by anesthesiologists and surgeons as a safe and practical means of providing analgesia and muscular relaxation of the upper extremity. There is, however, one major difficulty associated with the axillary approach. The musculocutaneous nerve leaves the axillary neurovascular compartment at the level of the neck of the humerus, approximately 3 cm. proximal to the usual axillary injection site, so that complete interruption of conduction in the musculocutaneous nerve is more difficult to achieve than in the median, ulnar, and radial nerves.

A variety of axillary approaches to the musculocutaneous nerve have been proposed. In Hirschel's original procedure for axillary block,[1] the needle was directed several centimeters cephalad along the course of the axillary artery toward the first rib. The nerve also may be blocked where it lies within the coracobrachialis muscle close to the humerus,[2] but in our experience the lack of well-defined landmarks has made this method unreliable. A more frequently employed technique is the injection of a large volume (40 to 50 ml.) in the axillary neurovascular compartment.[3, 4] The aim of this latter technique is to force the solution to the level of the origin of the musculocutaneous nerve at its junction with the lateral cord of the brachial plexus.[5, 6]

One problem with the latter technique, however, is that use of such a large volume, especially in more concentrated (1.5 or 2 per cent) solutions, may exceed maximum safe dosage limits. As a result, the cautious physician frequently injects less than an adequate volume of anesthetic and axillary block may be inadequate.

To avoid the hazard of exceeding safe dosage limits, attempts have been made to reduce the volume required to fill the axillary neurovascular compartment to the level of origin of the musculocutaneous nerve by distal occlusion of the compartment with a tourniquet.[7] Although difficult to evaluate, it has been our

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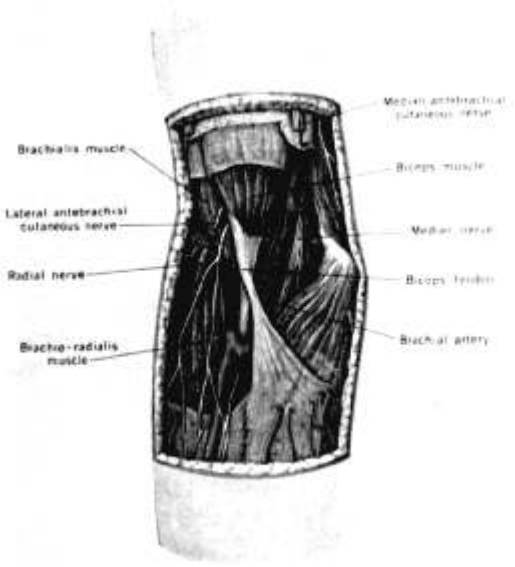

FIG. 1. Anatomical relationships at the elbow. Note emergence of lateral antebrachial cutaneous nerve from the cleft between the biceps and brachialis muscles. The radial nerve—covered by the brachioradialis muscle—lies in close proximity to the injection site and may be reached by piercing the brachioradialis.

clinical impression that this technique does tend to limit distal spread of the solution within the compartment. Radiographic observations reported by Eriksson and Skarby tend to support this impression.[7]

The following modified technique has been developed in an effort to include the musculocutaneous nerve in the block without the necessity of using large volumes.

Anatomical Relations of the Musculocutaneous Nerve

The musculocutaneous nerve is one of the two major terminal branches of the lateral cord of the brachial plexus. Unlike the radial, ulnar, and median nerves, which lie in close proximity to the axillary artery in the neurovascular compartment of the axilla, the musculocutaneous nerve leaves the neurovascular compartment immediately upon branching off the lateral cord at approximately the level of the neck of the humerus. It then enters the coracobrachialis muscle, to which it sends muscular branches. At the usual level of injection for axillary block, the musculocutaneous nerve lies close to the medial surface of the humerus, within the coracobrachialis muscle. Although the nerve may be blocked at this location, the lack of reliable landmarks makes the approach imprecise.

In the upper arm the nerve lies in the areolar tissue between the biceps and brachialis muscles, sending muscular branches at various intervals to these muscles; it maintains this position in its distal course until it reaches the distal lateral superior surface of the brachialis muscle, approximately 5 cm. proximal to the elbow crease at the lateral edge of the biceps muscle where the tendon begins to form (fig. 1).

At this point, the musculocutaneous nerve has lost all its motor branches and is sensory in nature only, continuing distally as the lateral antebrachial cutaneous nerve to supply the lateral aspect of the forearm and wrist, in some cases even including the base of the thumb.

The nerve becomes subcutaneous after it leaves the region between the brachialis and the biceps muscles, and remains subcutaneous, giving off numerous small cutaneous branches, along its course in the forearm.

Technique

We have had good results with use of a technique that combines an injection of a moderate volume (20 to 25 ml.) of local anesthetic solution into the axillary neurovascular compartment, digital occlusion of the distal neurovascular compartment, and a supplementary injection of the terminal branch of the musculocutaneous nerve—the lateral antebrachial cutaneous nerve—with 5 ml. of solution at the elbow.

Axillary Block. The previously described technical details for the axillary approach to the brachial plexus remain essentially unaltered except as noted below. The volume of solution injected into the neurovascular compartment has been reduced to 20 to 30 ml., with 25 ml. most frequently used. Our own experience is limited to the use of 1.5 per cent lidocaine (Xylocaine) with 1/200,000 epinephrine, or 1.5 per cent mepivacaine (Carbocaine) without epinephrine. For the robust patient, where complete muscular relaxation

of the forearm is desired, 2 per cent lidocaine with 1/200,000 epinephrine or 2 per cent mepivacaine may be employed.

For injection, the left hand grasps the patient's upper arm, with the left thumb placed over the axillary artery just distal to the site of injection, and the fingers lying over the biceps and deltoid muscles. After the needle has been satisfactorily placed, moderate pressure to occlude the neurovascular compartment is exerted by the left thumb over the axillary artery and pressure is maintained until the injection is completed.

Lateral Antebrachial Cutaneous Nerve Block. The landmarks for block of the lateral antebrachial cutaneous nerve at the elbow are superficial and easy to identify. When approached at the recommended site, the musculocutaneous nerve is blocked proximal to its cutaneous branches; thus, complete analgesia of its sensory innervation of the forearm and wrist is possible.

Upon completion of the axillary block as described above, the lateral antebrachial cutaneous nerve is approached as follows: The patient's arm is placed on a comfortable support such as an arm board and, with the elbow slightly flexed, the hand is pronated so that the palm rests on the arm board. At the elbow crease, the lateral edge of the biceps tendon is identified by palpation and traced proximally to identify the lateral edge of the biceps muscle. Just underneath the fingers is the soft substance of the brachialis muscle which extends laterally.

A 22-gauge needle 5 cm. long, with filled syringe attached, is inserted approximately 2.5 cm. proximal to the elbow crease and is advanced subcutaneously along the lateral edge of the biceps tendon and muscle, to run parallel with the cleft dividing the biceps and brachialis muscles. Total length of insertion is from 4 to 5 cm. (fig. 2).

Five milliliters of the local anesthetic of choice is injected, following repeated aspiration, as the needle is slowly advanced along the cleft and then withdrawn. The aim of this procedure is to deposit a wall of local anesthetic along the area where the lateral antebrachial cutaneous nerve emerges from between the lateral inferior edge of the biceps and the lateral superior surface of the brachialis.

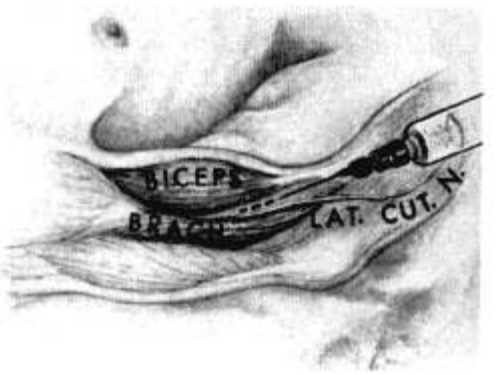

FIG. 2. Surface landmarks. Forearm, with hand pronated and elbow slightly flexed, rests on a support. The lateral edge of the biceps tendon is identified proximally to the elbow crease and infiltration is carried out along the inferior lateral border of the biceps. Purpose is to deposit local anesthetic solution in the cleft separating the lateral inferior surface of the biceps from the underlying brachialis muscle.

The only major structures that may be encountered along the course of the needle, aside from the two muscles and the nerve, are superficial tributaries to the cephalic vein; their proximity makes careful aspiration before injection mandatory.

Results

Modified axillary block has been performed by anesthesia residents in various stages of training on 20 patients varying in age from 16 to 57. Results of the modified axillary block were comparable to those obtained with the large-volume single injection technique for axillary block. Sixteen of the 20 blocks were successful. Two required an additional injection, one of the lateral antebrachial cutaneous nerve, and one of the ulnar nerve at the elbow. The block in the remaining two patients was spotty and was supplemented by general anesthesia rather than by an additional block procedure because the operation was already in progress. Total amounts of lidocaine or mepivacaine employed were 300 to 600 mg., but a 500 mg. limit was exceeded only in young and robust patients. No complications attributable to technique or agent were encountered.

It should be noted that the modified axillary block technique will usually not provide block of the motor branches of the musculocutaneous nerve, so function of the brachialis, biceps, and coracobrachialis muscles will not be interrupted. If motor block of these powerful arm muscles is desired, the large-volume technique of axillary block, combined with distal digital compression of the neurovascular compartment, is recommended.

Summary

Modified axillary block of the brachial plexus is a technique aimed at reducing the volume, and thus the total drug dosage, required to insure more satisfactory block of the musculocutaneous nerve in addition to block of the median, ulnar, and radial nerves.

Modifications of the previously described technique consist of (1) injection of 25 ml. of local anesthetic solution in the axillary neurovascular compartment, (2) occlusion of the distal portion of the neurovascular compartment during the injection by digital compression over the axillary artery to promote proximal spread of the solution, and (3) injection of 5 ml. of solution at the lateral cleft between the biceps and brachialis muscles at the elbow, to block the lateral antebrachial cutaneous (terminal musculocutaneous) nerve.

The above recommended approach has given satisfactory results in adults. Proportionate reductions in volume are indicated when it is employed with children.

Anatomical dissections were carried out in the Department of Anatomy under the guidance of Professor I. W. Monie. Residents of the Department of Anesthesia willingly cooperated in this study.

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ELECTROENCEPHALOGRAM Electroencephalographic studies were carried out in 26 patients during anesthesia with trifluoroethylvinyl ether (Fluoromar). Nine specific patterns were classified, which were correlated with the concentrations of Fluoromar in arterial blood and clinical signs. Close correlation was observed between the blood concentrations and the electroencephalographic patterns. Consciousness was lost at the beginning of pattern II with a mean blood level of 12.9 mg. per cent, and surgical anesthesia was maintained in well-established pattern II (15–20 c.p.s., 50–75 μv.) to pattern VI (1–2 c.p.s., 100–150 μv., interposed with fast waves of 12–20 c.p.s.) with mean blood levels from 18.6 to 41.9 mg. per cent. The so-called burst suppression was observed in pattern VII with a mean blood level of 49.4 mg. per cent. Nitrous oxide, when added to Fluoromar, definitely reduced the blood concentration of Fluoromar necessary to produce a given electroencephalographic pattern. *Iwatskuki, K., and others: Electroencephalographic Patterns During Anesthesia With Fluoromar (Japanese), Tohoku J. Exp. Med. 82: 52, 1964.)*