PROLONGED PERIPHERAL NERVE BLOCK BY MEANS OF INDWELLING PLASTIC CATHETER. TREATMENT OF HICCUP

(NOTE ON THE ELECTRICAL LOCALIZATION OF PERIPHERAL NERVE)

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THE patent undesirability of repeating the same nerve blocking procedure numerous times on the same patient has led the authors to adapt a modification of the continuous intraspinal catheter technic (1, 2) to peripheral nerve blocking procedures. Ansbro partially overcame this difficulty for periods of time entailed in prolonged operative procedures by fixing a needle in place in the region of the brachial plexus (3). The technic proposed is straightforward and permits repeated injections of the anesthetic agent when indicated over a prolonged period of time (days) without causing the patient additional discomfort.

Figure 1 shows the equipment. It consists of *A*, a 9-inch length of tested polyethylene tubing with an inside diameter of 0.023 inch, outside diameter 0.038 inch;† *B*, a stilet which is only about 1/32 inch shorter than the tubing (so as to prevent kinking of the catheter after it is inserted); *C*, a thin-walled, 2 inch, number 18 needle‡ through which the tubing and stilet will pass; *D*, a blunt, number 23 needle which fits snugly into the proximal end of the tubing after it is inserted; *E*, a needle stopper for occluding the needle opening between injections.

The method used is as follows. After the skin wheal is made, the number 18 needle is inserted to the desired point in the conventional manner. The tubing and its contained stilet are then inserted to the full length of the needle, and the needle is gently withdrawn over the tubing while making continuous and firm pressure on the stilet to prevent its displacement while withdrawing the needle. After the needle point is out of the skin, the stilet is removed from the tubing which is then firmly held in place while the needle is removed. The number 23 needle is inserted in the open end of the tubing and the anesthetic agent in-

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† Clay Adams, Inc., New York, Catalogue No. PE 50.

‡ Courtesy of Dr. Oscar Schwidetsky, Becton-Dickinson Co., Rutherford, N. J.

jected. When the desired block has occurred, the needle stopper is secured in the hub of the needle.

Probably the most important step in the sequence is securing the plastic tubing to the skin. Failure to do this carefully may have accounted for several of the early failures with this technic which resulted in displacement of the tubing. A heavy coating of collodion is applied to the skin in a circle with a radius of about 1 inch from the point of emergence of the tubing. This is done in such a way as to make the tubing adhere firmly to the skin surface. Narrow strips of adhesive tape wound several times around the tubing are then fixed to the skin at the edge of the collodion circle. The remainder of the tubing, the needle in its end and the needle stopper are then folded in a sterile gauze sponge and taped in place.

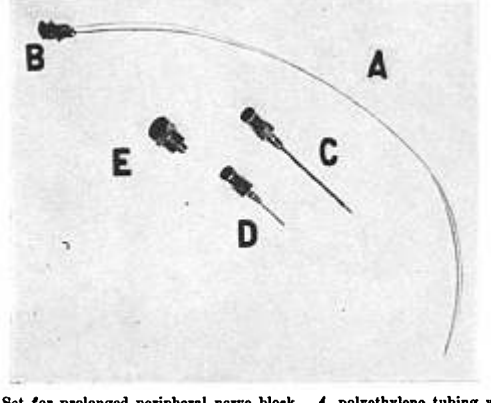

FIG. 1. Set for prolonged peripheral nerve block. *A*, polyethylene tubing with *B*, stilet inserted; *C*, *thin-walled*, 2 inch, number 18 needle; *D*, a blunt number 23 needle with *E*, needle stopper.

Vinylite tubing was originally used but was discarded when it was found that after it had been in place for some time it became brittle and much less pliable than when originally inserted. Subsequent inquiries revealed that the plasticizer used in making the vinylite pliable is soluble in animal fat and leaves the plastic soon after contact with tissue. Polyethylene, therefore, seemed to be the material of choice, especially since it had been extensively tested in the living organism. In addition, a large variety of sizes of tubing can be obtained, batch samples of which have been tested by previous implantation in experimental animals. There is no reason why smaller-sized tubing cannot be used with nerve block needles of smaller caliber. Since re-

peated injections of required amounts of an anesthetic agent can be safely and painlessly made as required, this technic was tried on patients who had intractable hiccup. In all cases studied, the electrophrenic respirator § was used for localizing the *external* motor point of the phrenic nerve (4) (fig. 2). The number 18 needle was inserted at this point and made to follow the downward course of the anterior surface of the anterior scalene muscle over which the phrenic nerve passes.

FIG. 2. Motor point of phrenic nerve.

It was sometimes possible to sense the passage of the needle through the prevertebral fascia which overlies this structure. If patients with intractable hiccup are not too ill for fluoroscopy, this is highly advisable, since gross observation of the diaphragm is not always reliable in establishing which side or sides are producing the hiccup.

The accurate placement of the tip of the needle and catheter is important to the success of the procedure. In the last 2 patients studied,

§ Sanborn Company, Cambridge, Mass.

therefore, we adapted a previously described method of electrical localization of catheters to the purpose. The localization of the tip of a spinal catheter and stilet in the subarachnoid space without the aid of roentgenograms or fluoroscopy had previously been accomplished by observing the segmental motor response that results from applying an electrical potential to the tip of a catheter by way of its stilet in the subarachnoid space (5). The same principle was used in localizing the tip of the needle in relation to the phrenic nerve in this study.

The stimulating needle used is insulated by means of baked-on silicon except at its tip, and a sponge moistened with saline solution

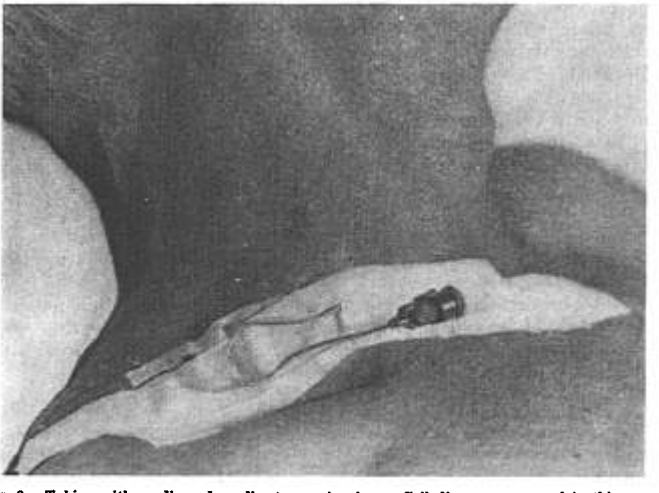

FIG. 3. Tubing with needle and needle stopper in place. Collodion was not used in this case.

and placed behind the shoulder, serves as the indifferent or dispersive electrode. The needle is then inserted down to the place where it is thought that the phrenic nerve passes over the anterior scalene. It is then electrically tested. The position of the needle point is carefully varied until the maximal diaphragmatic response with the lowest possible voltage is obtained. The lead wire clip is then removed and the needle left in position until the plastic catheter is inserted. The electrophrenic respirator was the source of current used, but any appropriate impulse generator would serve as well. Since motor fibers have a much lower electrical threshold than pain fibers, motor activity occurs at a lower current density than that at which pain fibers are ac-

tivated, and as a result the only sensation experienced by the patient is the appreciation of the externally induced motor reaction.

Figure 3 shows the tubing in place in a 70-year-old man in whom right-sided intractable hiccup was seriously threatening the patient's convalescent following an abdomino-perineal resection for carcinoma of the rectum. Before therapy was begun the patient had been hiccuping continuously for seventy-two hours. The intensity of the diaphragmatic contractions had brought about partial disruption of his abdominal wound, and resuturing of the wound had to be performed after the hiccups were brought under control. Following the insertion of the indwelling plastic catheter it was possible to keep the patient free of hiccups except for those brief periods when the effect of the previous injection had disappeared and before the next injection was made. Treatment was required for three days, at the end of which time the tendency to hiccup was greatly diminished and soon disappeared. Two replacements of the catheter were required during the three days of treatment. Collodion was not used for securing the catheter to the skin in this patient.

In a subsequent patient, a 46-year-old man with a history of intermittent but intractable hiccups, for seven days, the initial catheter remained in place for six days after being secured with collodion. During this period 2 per cent procaine hydrochloride (and on two occasions 0.1 per cent pontocaine hydrochloride) was injected through the catheter. This was followed by the desired therapeutic effect. Although the previously observed spontaneous remissions made it difficult to be certain that a causal relationship existed, this patient's hiccups could be consistently provoked by drinking or eating when the phrenic nerve was not blocked. After the injections through the catheter were made, this reaction could not be obtained.

MISCELLANEOUS CONSIDERATIONS

The anatomic variation of the phrenic nerve is considerable, as shown by the recent extensive studies of Rajanna (6) and others, especially those which applied to the accessory phrenic nerve or nerves. Diminution in the hiccups without abolishing them may, therefore, occur either because the hiccups are bilateral initially or because not all the phrenic nerve fibers are blocked. Fluoroscopy is most desirable under these circumstances.

If the hiccups are bilateral, the procedure may have to be repeated on the second side. In the absence of pulmonary parenchymal involvement, this repetition is without hazard in view of the extent of the respiratory reserve. It must be remembered, however, that the possibility of blocking the vagi does exist, and if the procedure is done bilaterally the vocal cords should be visualized before injection is made on the second side and not sooner than thirty minutes after injection of the first side.

The blocking effect of the initial injection is generally more rapid in onset and requires a smaller amount than subsequent injections. It might be expected that slight displacement of the catheter is the cause of this, but the observations of Smith and Rees (7) in prolonged spinal anesthesia in man indicate that at the end of forty-eight hour periods greater doses of anesthetic agents were required than were initially necessary. We have noted the development of this phenomenon in as little as eight hours in experimental catheter spinal anesthesia in the dog.

On reviewing our data, we find that in no case did we administer comparable doses of the anesthetic agent at an indifferent site. We have not, therefore, ruled out the possibility that the procaine was absorbed and exerted its effects systemically.

SUMMARY

In summary, it is suggested that (1) precise localization of peripheral nerves can be accomplished by applying an electrical potential to the insulated nerve block needle when it is thought to be in the proper position; (2) an indwelling plastic catheter can be used to permit intermittent readministration and prolonged local nerve block if the catheter is firmly secured in place; (3) this is a feasible means of treating intractable hiccups when the conventional therapeutic measures fail and surgical intervention is undesirable, and (4) these concepts are simple enough to make us doubt their originality, but examples of their previous use have not come to our attention.

REFERENCES

1. Tuohy, E. B.: Continuous Spinal Anesthesia; New Method Utilizing Ureteral Catheter, S. Clin. North America 25: 834–840 (Aug.) 1945.
2. Saklad, M.; Dwyer, C. S.; Kronenberg, S.; Neves, E., and Sarbrin, M.: Intraspinal Segmental Anesthesia; Preliminary Report, Anesthesiology 8: 270–287 (May) 1947.
3. Ansbro, F. P.: Method of Continuous Brachial Plexus Block, Am. J. Surg. 71: 716–722 (June) 1946.
4. Sarnoff, S. J.; Whittenberger, J. L., and Sarnoff, L. C.: Electrophrenic Respiration (EPR). VII. Motor Point of Phrenic Nerve in Relation to External Stimulation. In press.
5. Sarnoff, S. J.: Functional Localization of Interspinal Catheters, Anesthesiology 11: 360–366 (May) 1950.
6. Rajanna, M. J.: Anatomical and Surgical Considerations of Phrenic and Accessary Phrenic Nerves, J. Internat. Coll. Surgeons 10: 42–52 (Jan.–Feb.) 1947.
7. Smith, S. M., and Rees, V. L.: Use of Prolonged Continuous Spinal Anesthesia to Relieve Vasospasm and Pain in Peripheral Embolism, Anesthesiology 9: 229–238 (May) 1948.