CONTINUOUS SPINAL ANESTHESIA: ITS USEFULNESS AND TECHNIC INVOLVED

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CONTINUOUS spinal anesthesia introduced and widely reported on by Lemmon (1) has certain advantages which are worthy of re-emphasis and comment. It should be remembered that the primary motive for developing this method of anesthesia was to utilize a local anesthetic agent which was relatively nontoxic as a spinal anesthetic agent and to administer it in fractional doses. The advantage of the serial or fractional doses should be axiomatic since the anesthetic agent may be added as it is needed and the necessity of administering a large or relatively large amount at one time, the so-called single dose method, is eliminated.

Of the various anesthetic agents which are available at present for spinal anesthesia, procaine hydrochloride (novocaine), metycaine hydrochloride and pontocaine hydrochloride are most in favor. On the basis of relative toxicity Lemmon and others (1, 2) have stated that procaine hydrochloride is the agent of choice.

The indications for continuous spinal anesthesia are essentially the same as those for any spinal anesthesia. Theoretically this method should be utilized whenever spinal anesthesia is indicated, but from a practical standpoint it is somewhat complicated for every situation in which spinal anesthesia is indicated or desirable. For example, for transurethral prostatic resection or hemorrhoidectomy, in which small amounts (50 to 90 mg.) of the anesthetic agent are used, it is not necessary nor ordinarily practicable to utilize the continuous spinal technic. I believe that the method has its greatest usefulness in such surgical procedures as bilateral primary herniorraphy, operations for recurrent inguinal hernia and ventral hernia, certain abdominal laparotomies in which the surgical risk is good, such as operations on the biliary tract or stomach, lengthy orthopedic procedures on the hips or lower extremities, and so forth. Surgical procedures which carry an increased likelihood of hemorrhage, such as splenectomy or cesarean section, I believe, should not be done under spinal anesthesia by either the single or continuous dose method, unless after all factors have been taken into consideration its use is still deemed advisable as, for example, in the presence of active pulmonary tuberculosis. By and large, debility, cachexia and impending surgical shock should deter any anesthetist from the use of any method of spinal anesthesia, and other methods or combinations of agents and methods should be employed to obtain safe and adequate

anesthesia. The advantages of the so-called balanced anesthesia (3) have been recognized for some time and are worthy of consideration when dealing with poor surgical risks.

THE METHOD OF LEMMON

From a technical standpoint, the method of continuous spinal anesthesia advocated by Lemmon presents one or two difficulties, and these must be handled carefully in order to have the system work properly. Firstly, the use of a malleable needle may make lumbar puncture somewhat difficult because the needle bends easily. Secondly, in some cases the arachnoid puncture will be troublesome because the bevel of the malleable needle will not easily pierce the dura and the arachnoid. In a measure the dura and arachnoid are pushed ahead of the needle without the needle effecting a puncture. After a satisfactory lumbar puncture has been made, the patient must be turned carefully onto his back so that the needle will not be dislodged from the subarachnoid space. The assistance of two or three persons is usually required to turn the patient onto his back without moving the needle out of position. At this juncture the rubber tubing connected to the needle is attached to a syringe (10 cc.) and the patency of the system is tested by aspiration. If spinal fluid cannot be satisfactorily aspirated, the needle should be readjusted so that spinal fluid will aspirate freely.

Dosage and Site of Injection.—In preparing the anesthetic solution for continuous spinal anesthesia, 400 mg. of procaine hydrochloride (4 cc. of 10 per cent solution) is diluted with spinal fluid up to a total volume of 12 cc. A 3 per cent solution results and each cubic centimeter contains 30 mg.

Crystals of procaine dissolved in spinal fluid or in physiologic saline solution may be used interchangeably with the 10 per cent solution of procaine hydrochloride (4, 5). Either preparation of procaine is satisfactory; however, the prepared solution is more convenient. A 10 per cent solution of metycaine likewise is satisfactory and usually is used in a 3 per cent dilution. Smaller concentrations, for example, 2 to 2.5 per cent solutions of procaine or metycaine, should be used for operations in the upper part of the abdomen because they will allow the injection of a greater volume of solution without increasing the initial total dose, and thus anesthesia will be produced sufficiently high for upper abdominal laparotomy.

The rubber tubing which leads from the syringe is filled with the anesthetic solution (about 2 cc.) before attaching the tubing to the hub of the spinal needle, so that the initial subarachnoid dose should be calculated only after carefully filling the length of rubber tubing from the syringe. The initial dose of procaine varies usually between 100 and 120 mg., depending on the type of operation and status of the patient. The site of injection should be either the space between the third and fourth or the second and third lumbar vertebrae. There is danger

of trauma to the cord structures if injection is made at levels higher than these, especially since the needle is left in place for the duration of the operation. The rate of injection should be about 0.5 cc. per second. Some authors advocate barbotage with this technic, especially when it is necessary to have anesthesia extend high enough for an upper abdominal operation. It is more difficult to calculate accurately the dosage if barbotage is used, but this method may be required in certain instances in order to have anesthesia extend high enough. Use of the less concentrated solutions will usually obviate the necessity of any barbotage. As with any type of spinal anesthesia, the height and duration of anesthesia are dependent on the volume of solution, rate of injection, the site of injection, and total dose.

Premedication.—Vasopressor agents, such as ephedrine, neosynephrin, and so forth, are used preliminary to the spinal anesthesia in order to help counteract the fall in blood pressure which is usually coincidental with subarachnoid injection of a spinal anesthetic agent. Ephedrine is employed in doses of from 25 to 50 mg. and neosynephrin in doses of 1 to 3 mg. Each is injected intramuscularly before administration of the spinal anesthetic agent. Barbiturates and morphine are definitely helpful premedication agents for operations performed under regional and spinal anesthesia and should be administered in sufficient quantity to allay apprehension and fear. Pentobarbital sodium (nembutal), from 1½ to 3 grains (0.1 to 0.2 Gm.) given orally the evening before operation and again in the morning about one hour before operation along with morphine sulfate, grains ⅙ to ¼ (0.01 to 0.016 Gm.), and atropine sulfate, grains $\frac{1}{150}$ (0.00043 Gm.) given hypodermically, are sufficient premedication for the average adult.

An Alternative Method: Use of an Ureteral Catheter

In lieu of a malleable needle for continuous spinal anesthesia, I have utilized an ureteral catheter for this purpose. The reports of the use of the ureteral catheter for caudal anesthesia (6, 7) and for continuous subarachnoid drainage for meningitis as advocated by Love (8) suggested the possibility of using a catheter for the purpose of continuous spinal anesthesia. This procedure in no way alters the fundamental premises of the method originally suggested by Lemmon (1), but merely offers another method for performing the same anesthetic procedure. Irving (9) suggested that a number 4 ureteral catheter can be introduced through a number 15 gage needle just as a number 5 ureteral catheter can be passed through a number 13 gage needle for continuous caudal anesthesia. In developing the catheter technic for spinal anesthesia, I have found that a number 15 gage needle could be introduced into the subarachnoid space without difficulty, provided one of the lower lumbar interspaces is utilized, namely the space between the third and fourth or the fourth and fifth lumbar vertebrae.

The objective which prompted the trial of a catheter for continuous spinal anesthesia was to find a method which would eliminate some of the technical difficulties associated with the use of a malleable needle. The obstacles and technical difficulties briefly are those associated with the introduction of the needle, holding the needle accurately in the subarachnoid space, trauma to tissues incidental to the needle, and lastly the remote hazard that the needle will break. It seemed to me that the number 4 ureteral catheter is less traumatic than a needle when it is left in position for the duration of an operation and that the catheter will not become dislodged as easily as a needle from the subarachnoid space. Lastly, a special operating table mattress is not required for this method.

Technic.—The introduction of the ureteral catheter number 4 is accomplished by the following method: The skin and subcutaneous tissues at the site of puncture are anesthetized with 1 per cent solution of procaine hydrochloride, and a number 15 gage needle, 3 to 3½ inches (7 to 9 cm.) in length, with a flush fitting stylet, is inserted into the subarachnoid space. Following this the stylet is removed and the catheter is inserted through the needle and into the subarachnoid space. Centimeter markings on the catheter are used to measure with so that one can determine how far to introduce the catheter. The tip of the catheter is advanced about 4 to 5 cm. beyond the end of the point of the needle into the subarachnoid space. This is sufficiently far to prevent the catheter from slipping out of place. The number 15 gage needle is removed from the intervertebral space and slid off the free end of the catheter. A rubber adapter for ureteral catheters which will fit a Luer type of syringe is placed on the free end of the catheter, and preparation for injecting the anesthetic agent via the catheter is complete. In the absence of this rubber adapter, a 22 gage needle may be inserted into the free end of the catheter and the hub of this needle attached to a glass Luer type of syringe. Since the bore of the number 4 ureteral catheter is so small, little solution is needed to fill its lumen, and it is not necessary to allow for this minute loss of solution in calculating dosage of the anesthetic agent.

The anesthetic solution is prepared in the same manner and is used in the same concentrations as when the technic devised by Lemmon is employed. The initial dose also is the same except for the slight variation just mentioned. In general, the initial dose should be a fourth or a fifth less than the dose contemplated for a single dose type of spinal anesthesia. For example, if 150 mg. of procaine would be needed in a single dose, 120 mg. would be the initial dose in continuous spinal anesthesia.

When the initial dose has been injected, the patient is turned carefully onto his back and the catheter is brought out to his side and fastened in place with adhesive plaster. Most catheters are sufficiently long to permit the syringe attached to the catheter to be placed near

the patient's shoulder, and thus make the equipment accessible and ready for additional injections of the anesthetic agent.

Additional amounts of the anesthetic agent should be injected at the first indication that the patient is having pain or if there is evidence of lack of muscular relaxation. Usually within thirty-five or forty minutes it is necessary to add additional amounts of the anesthetic agent. Two cubic centimeters or about 60 mg. is the usual amount required, and this will be sufficient for another twenty to thirty minutes. Subsequent doses are added in the same manner as they are required. The total amount of anesthetic agent in milligrams will vary in accordance with the magnitude of the operative procedure and the physical status of the patient. Lemmon and Paschal (2) and Apgar (3) have reported total doses of 2,100 and 1,700 mg. respectively in certain cases. These are some of the largest if not the largest amounts on record at present. Naturally, the time factor as it pertains to the operative procedure will materially affect the total dosage.

At the completion of the operative procedure, the subarachnoid space may be irrigated with physiologic saline solution, as was suggested by Lemmon (10), and in many instances the action of the spinal anesthetic agent can be terminated in a short period. This procedure may or may not be of practical value or importance. Before removing the catheter the patient is turned on his side and, if possible, the knees and head and shoulders are flexed; this is the same position as that employed when the catheter was introduced. The catheter then is withdrawn gently. The purpose of flexing the patient is to relieve any tendency for the spinous processes of the vertebrae to impinge on the catheter. The catheter is examined to determine if there has been any break in its continuity. No surgical dressing is required as a rule over the site of puncture.

Supportive Measures.—It is noteworthy that as a rule after the initial dose of the anesthetic agent in continuous spinal anesthesia the systolic blood pressure changes little if any. Of course, hemorrhage and surgical trauma will affect blood pressure, but specific decreases in blood pressure following secondary injections of the spinal anesthetic agent are not usually seen. Thus, with small initial doses of procaine there is a minimal decrease in systolic pressure. Vasoconstrictors, such as ephedrine or neosynephrin, are used to help support blood pressure and are administered just before the spinal anesthetic agent is injected. The usual amounts employed are 25 mg. of ephedrine or 2 mg. of neosynephrin.

In the event that blood pressure falls during continuous spinal anesthesia, for example, in operations in the upper part of the abdomen, this situation should be counteracted by an intravenous infusion of glucose and saline solution, plasma or whole citrated blood. The choice of solution depends on the severity of the circumstances. This procedure is entirely in keeping with the prophylactic treatment of surgical shock

rather than the therapeutic management of it. Nausea and retching are encountered periodically in continuous as well as in single dose spinal anesthesia, especially in operations in the upper part of the abdomen. These difficulties can be alleviated usually by the inhalation of oxygen and carbon dioxide mixtures, light gas-oxygen anesthesia or by the intravenous administration of a 2.5 per cent solution of pentothal sodium. The last method is the most effective in my experience. A necessary precaution in using pentothal sodium for this purpose is slow administration in fractional doses so that respiratory depression is not produced. Respiratory depression may develop since in high spinal anesthesia (for exploration of the upper part of the abdomen) some of the lower intercostal muscles are not active and pulmonary ventilation is somewhat reduced.

Complications.—The incidence of headaches following continuous spinal anesthesia has not been any greater than that observed following single dose spinal anesthesia or routine spinal puncture. To my knowledge, there have been no instances of persistent paresthesia following the catheter technic.

COMMENT

The catheter technic, as compared with the use of a malleable needle, has been attended by fewer mechanical difficulties in my experience. It is easier to maintain the catheter than the needle in the subarachnoid space, and less equipment is required. I believe the catheter causes less trauma to tissues than a malleable steel needle over a protracted period. Objections have been directed against the use of a number 15 gage needle which serves to introduce the number 4 catheter, on the basis of its large size and increased hazard of trauma. If the lower lumbar interspaces are used as sites of puncture, that is, the space between the fourth and fifth or the third and fourth lumbar vertebrae, they are sufficiently large to permit the introduction of the 15 gage needle with minimal technical difficulty. A question has been raised concerning the direction the catheter will advance in the subarachnoid space after the tip of the catheter leaves the end of the guiding needle. The direction cannot be predicted positively, but if the tip of the catheter is bent slightly before introducing it into the needle, I have found that the catheter will advance cephalad in most cases. This has been determined and verified by using leaded ureteral catheters which are opaque radiographically. If the catheter turns caudad on entering the subarachnoid space, this fact can usually be surmised or detected shortly after the first dose of the spinal anesthetic agent has been introduced because of the segmental distribution of the resulting anesthesia. Under these circumstances it is suggested that the remaining amount of the anesthetic solution in the syringe be diluted with an equal volume of saline solution in order to make a 1.5 per cent solution of procaine hydrochloride. Twice as much solution (volume) should then be injected

when additional dosages are required. In other words, with this concentration (1.5 per cent), 4 cc. of solution will be required to deliver 60 mg. of procaine. The increase in volume will produce higher segmental anesthesia and permit incisions in the upper portion of the abdomen.

The possibility of breakage of a catheter is always potentially present, but I do not think the hazard is as great as with a needle. I have not used one catheter for more than six operations, but I have no reason other than possibly intuitive apprehension for not employing the same catheter for more than this number. Any obvious breaks or cracks in the catheter should be reason enough for its disposal. Sterilization of the catheters can be done either by autoclaving for ten minutes at 15 pounds (6.8 Kg.) of pressure, or by cold irrigation for one and a half hours in 1:1,000 solution of bichloride of mercury.

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The Section on Anesthesiology of the American Medical Association will be held during the week of the Scientific Session in Chicago, June 12–16, 1944. The scientific sessions and the technical exhibits will be held in the Stevens Hotel and the scientific exhibits in the Palmer House.