CONTINUOUS SPINAL ANESTHESIA *

VIRGINIA APGAR, M.D. †

New York City

THE purpose of this report of 422 cases of continuous spinal anesthesia is neither to contribute anything new to the technic nor to add statistics to the already mathematical literature, but to discuss some of the difficulties met while using this method.

Seven clinical papers (1, 2, 3, 4, 5, 6, 7) have appeared on the subject, and one experimental report (8). The details of administration as set forth by Lemmon in 1940 (3) have been changed little by the subsequent exponents of this method. Once more we are indebted to a surgeon for making a substantial contribution to anesthesia. Later reports by Nicholson (5), Tuohy (7), Lemmon and Paschal (4), Nicholson, Eversole and Hand (6), Burford and Galvin (1), and Haugen, Ruth and Taylor (2) have added interesting details and suggestions for the smooth maintenance of anesthesia. For a description of the equipment, procedure of administration, advantages of the method, and indications for additional doses, reference may be made to these earlier papers.

It is interesting that the experimental paper appeared in the same month as the first clinical report. Popova (8) in Leningrad, in January, 1940, published a report of experiments in which fractional doses of 2 per cent procaine or 0.2 per cent nupercaine were given to 50 cats, and their physiological reactions were noted. Laminectomy was performed on each animal and from two to nine injections of the drug were made. The needle was not left in place, but was reinserted under direct vision before each injection. Carotid and tracheal cannulae were used to record blood pressure, respiratory rate and tidal volume. Popova established the fall in blood pressure was most marked after the first dose of the drug, and was much less marked after additional doses of the same size. He felt that this improvement was due to a compensatory increase in vasoconstriction. The animals showed an increase in blood pressure and respiration at the moment of the first tap, which was absent with subsequent punctures, probably because anesthesia was then established. He showed also that the tolerance to a drug was increased by its fractional administration, and was increased even more by the prophylactic use of ephedrin. With nuper-

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† From the Division of Anesthesia, Department of Surgery, Presbyterian Hospital, New York City.

caine, the fatal dose for a single injection was 1.0 mg., for fractional injections 5.8 mg. and with prophylactic use of ephedrin intravenously this was extended to 8.0 mg.

In our series, 15 individuals were anesthetized by the continuous spinal method twice, and one patient three times. The youngest patient was 17 years of age, the oldest, 85. Thirty-two patients were over 70. Forty per cent of the cases were upper abdominal operations; 55 per cent, lower abdominal, and 5 per cent extra-abdominal operations. Among the last group, there were 11 patients for wiring of aortic aneurysms, to whom spinal anesthesia was given to lower the blood pressure and reduce the circulatory time while the wire was being heated. A slowed circulation at the time of heating produces much better blood clot formation (9). In 50 per cent of the cases, the anesthesia time was over three hours. In five cases, laparotomy consumed more than six hours.

Procaine was the drug chosen and was used either in crystals dissolved in the patient's spinal fluid, in normal saline, or in the 20 per cent solution. A concentration of 5 per cent was employed in the majority of cases, although at the present time 2½ per cent solution is usually used for patients presenting serious risk. The highest dose, 1,700 mg. given during four hours and twenty minutes, did not approach Lemmon and Paschal's (4) record of 2,100 mg. We had no doses of less than 100 mg. comparable to the small doses reported by Ruth (2, 4). Intracaine and metycaine were used in a few cases, and proved satisfactory. With pontocaine, the time of action for each additional dose was delayed too long to make it as useful as procaine. Spinocaine was used for all patients placed in the prone position, and during abdominal perineal resections of the rectum, it was added just before the assumption of the lithotomy position for the perineal proctectomy.

Our chief difficulties have been in maintaining an adequate blood pressure, in controlling pain and retching associated with traction in the upper abdomen, and in carrying out certain technical parts of the procedure.

In 60 per cent of our cases the state of the circulation was unsatisfactory at some time during the operation. By this is meant a low systolic pressure, a small pulse pressure and usually a slow pulse rate. Clinically, the patients were pale, warm, and dry. The usual precipitating causes for the drop in pressure were (1) addition of too much procaine at one time, (2) traction on abdominal viscera, and (3) change of position during anesthesia. Although the same changes in circulation often occur during inhalation anesthesia from traction or change in position, it seemed that the changes were much pronounced during spinal anesthesia. It was sometimes difficult to produce a return of the pressure to normal levels. The addition of oxygen to the inspired air by oropharyngeal insufflation was tried in 126

cases, but in not one did it cause a rise in pressure, although it was occasionally followed by slowing of a rapid pulse. We did not use the pitressin-ephedrin combination mentioned by Nicholson (8). Ephedrin alone in divided doses usually sufficed. However, in 25 cases it failed to effect a rise of blood pressure. A similar experience has been reported by Rochberg. In these, a small amount of epine-

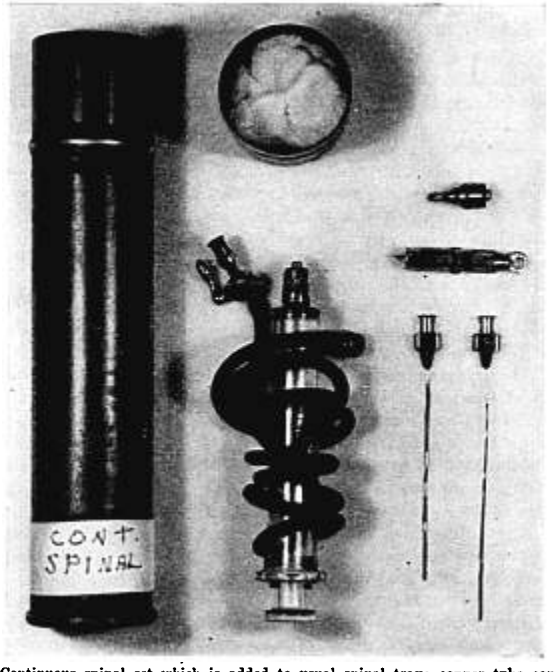

FIG. 1. Continuous spinal set which is added to usual spinal tray: copper tube containing syringe, tubing, two needles, stopper, lancet and sponge.

phrine (0.2 cc. 1:1000) given fifteen to twenty minutes after ephedrin, usually produced a moderate and sustained increase in pulse pressure and systolic pressure. The use of these drugs for this purpose is based on the work of Gaddum, Blatschko and others, who suggest that ephedrin acts by inhibiting the amine esterase which destroys epinephrine. It is true also that there must be circulating epinephrine present for ephedrin to be effective. It is possible that during high

spinal anesthesia, with all sympathetic innervation to the adrenal medulla paralyzed, not enough epinephrine is present in some cases for the effective use of ephedrin. The action of neosynephrin was more abrupt and more fleeting than that of ephedrin.

Our next unsolved problem was one of epigastric or substernal pain, with retching, vomiting or hiccoughs in the course of upper abdominal operations. These symptoms were most likely to occur when exploration of the upper abdomen was in progress, or when traction was exerted on the celiac axis, stomach, or gall bladder. At the same time there occurred bradycardia and a fall of pulse pressure, as in a celiac plexus reflex during inhalation anesthesia, though much more severe. Theoretically, cyclopropane is the best supplementary anesthetic agent to use with spinal anesthesia because its lack of irritating qualities allows rapid induction and quick change in the plane of anesthesia, and its potency allows ample admixture of oxygen. On the other hand, it should accentuate a celiac plexus reflex. We regret that we have had no opportunity to use this drug in conjunction with continuous spinal anesthesia. In an attempt to find a good substitute, pentothal, evipal, or nitrous oxide was used in 104 cases. Frequently, hiccoughs were not only not relieved, but made worse after induction of pentothal anesthesia. Nitrous oxide, even with an efficient absorption system, usually caused such increase of respiratory excursions as to interfere with the operative field. In 60 other cases, morphine and scopolamine were used as the supplement, and proved more satisfactory. These were usually given by the intravenous route, and the doses of the two drugs were in the ratio of 25:1. We encountered no respiratory depression although as much as 30 mg. of morphine was given in divided doses.

The patient's mental condition was kept depressed by preoperative medication with pentobarbital sodium in divided doses and morphine, usually with scopolamine, as well as by the previously mentioned supplementary anesthetic agents. A few patients became uncooperative, restless and talkative from the preoperative medication. They were all controlled by small amounts of 2½ per cent pentothal sodium.

There was a definite incidence of technical difficulties. In 5 cases not included in this series, continuous spinal anesthesia was attempted, but the needle could not be introduced. Most of these were elderly patients with advanced arthritis. In 4, a stiff spinal needle was successfully introduced. In 3 other patients, no anesthesia at all was obtained, although spinal fluid flowed freely and an adequate amount of drug was introduced. Probably only part of the tip of the needle rested within the epidural space. In 1 case, the needle became displaced while the patient was being moved from the supine to the lithotomy position. In another, after two hours of satisfactory anesthesia, the needle became plugged with a small foreign body. This rather high incidence of difficulties was due in part to the frequent changing of residents. Ten

physicians contributed to this series. We did not find that the side opening in the needle, recommended by Dill (2), assured a free flow of spinal fluid. In several cases there was difficulty in withdrawing the desired amount of fluid. An intermittent flow suggested obstruction of the tip by a nerve root. Two needles, used about two hundred times each, broke near the hub while being tested prior to sterilization.

We have been very interested in the effect of withdrawal of fluid at the end of operation, in relation to the recovery of sensation or motor

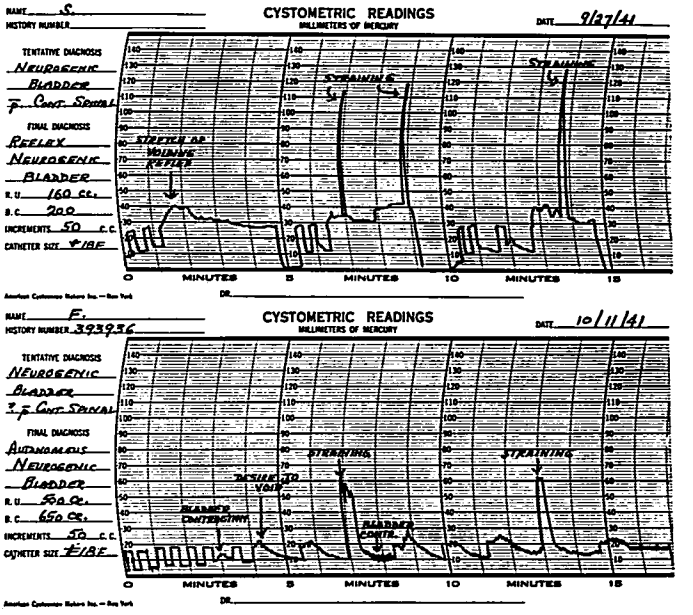

FIG. 2. Two types of bladder dysfunction after continuous spinal anesthesia.

ability. In 43 cases, 3 to 20 cc. was withdrawn at varying intervals after the last dose of procaine. In only one case did there seem to be a quicker recovery of motor activity than if no fluid had been withdrawn. Our observations on the disappearance of procaine from the spinal fluid indicated that procaine or paraminobenzoic acid was present in appreciable quantities as long as forty-five minutes after the last dose. We are not wholly satisfied with the tests for separating procaine from paraminobenzoic acid.

COMPLICATIONS

We are of the opinion that postoperative complications were slightly reduced by this technic. There were 30 deaths, none attributable directly to the anesthesia, though 4 cases of irreversible shock, with death within the first 48 hours, may be related to the type of anesthesia. One death following a negative exploratory laparotomy was found to be due to an acute crisis occurring in the course of sickle-cell anemia. A brief review of the literature shows that the death rate in the active phase of sickle-cell anemia is remarkably high, regardless of operation or anesthesia.

There were 31 cases of postoperative pneumonia or atelectasis, an incidence of 7.3 per cent, which compares favorably with a similar series of abdominal cases under inhalation anesthesia. One patient's cough reflex was so depressed that she aspirated vomitus during the operation of splenectomy, and in spite of thorough endotracheal suction, developed aspiration pneumonia and died.

Twenty-two cases, or 5 per cent, were catheterized during the postoperative period, in addition to those who were drained by indwelling catheters following abdominal perineal resection of the rectum. This figure compares favorably with the incidence of 11.9 per cent catheterizations in a series of 1,000 pontocaine spinal anesthesias (11). However, three of these were of great severity, lasting thirteen, fourteen and fifteen days. All recovered fully before discharge except one man, who still has considerable residual urine, and is incontinent with slight bladder distention.

Headaches have been infrequent. Only 4 were discovered, and these lasted for four, seven, eight and seventeen days, then completely disappeared.

Eleven known syphilitics were anesthetized by this method, most of them for wiring of an aneurysm. None of these showed any change or increase of syphilitic manifestations, although one of them had syphilis of the central nervous system.

In 6 patients lumbar puncture resulted in a bloody flow. In 1 of these anesthesia was difficult to maintain satisfactorily, but in the other 5 the presence of blood seemed to have no ill effect on the action of procaine.

In 8 cases, paresthesia of the leg, buttocks or hip was recorded. None of these showed acute or residual neurological changes.

There was one severe neurological reaction. In an elderly patient with arthritis, difficulty was experienced in introducing the malleable needle. A 22 gage, stiff spinal needle was easily introduced, and against our advice, was left in place throughout a four hour abdominal perineal resection. Fortunately the needle did not break, but the patient has residual paresis of the right leg, and trophic ulcers of the right metatarsal region and thigh. At the present time, three months

later, she can bear weight on the leg, but her activity is greatly limited by her disease.

There was another serious reaction that should have been avoided. A 31 year old lawyer underwent a five and one-half hour exploration of the common duct. Because of vomiting from traction on the common duct, 5 per cent pentothal was given intravenously after an unsuccessful trial of nitrous oxide anesthesia. It was necessary to give him 6,750 mg. of pentothal to keep him from vomiting during the remainder of the operation. Recovery was prolonged and was complicated by aspiration of vomitus. Although the trachea was promptly treated by aspiration, respirations became very rapid and marked restlessness developed. We strongly suspected that anoxia had caused irreversible changes in the central nervous system, but after two and one-half days, he recovered consciousness, and has no residual effects.

DISCUSSION

Much more extensive use of continuous spinal anesthesia in many clinics will be needed before an opinion can be formed concerning the proper choice of patients for this method. The surgeons have been the chief enthusiasts for its use. The method allows them unlimited operating time with excellent muscular relaxation of the patient. Although this sounds, and is, unphysiological at present, it must be realized that prolongation of the anesthetic time offers great advantages. New and more complicated surgical procedures cannot be performed quickly. If abdominal carcinoma is to be cured surgically, excision should be as wide and as thorough as in a radical mastectomy, a time consuming procedure. In a teaching hospital, operations performed by the younger surgeons take longer because of frequent didactic discussions during the course of the operation. If we are to be a real aid to the surgical team, there is a definite challenge to us to provide excellent surgical anesthesia for as long as the surgeon needs it, and, at the same time, to keep the patient in the best possible condition—"A most delightful paradox." I am not convinced that continuous spinal anesthesia is the best way to solve these problems. Another consideration of less importance is that the method presents no fire and explosion hazard in the presence of electrical equipment. This was the reason for the choice of this method in some of our cases.

One of the best features of this method was the absence of severe respiratory depression during operation. In the pontocaine series, with a similar type of surgery, this was present in 4 per cent of cases (11).

It is our impression that for operations in the upper abdomen endotracheal anesthesia with either cyclopropane or ether is more controllable and protects the patient better from a reflex disturbance. Controlled respiration during opening and closing of the peritoneum affords excellent muscular relaxation if more than the usual degree is required. In the field of lower abdominal surgery, and in prolonged

operations on the extremities, such as plastic surgery, or open reduction of comminuted fractures, we feel there is a definite place for continuous spinal anesthesia. For any operation which is likely to involve unusual blood loss, inhalational methods are better. Inhalation anesthesia still remains the only technic by which an anesthetic drug can be removed from a patient at will.

SUMMARY

Four hundred and twenty-two cases of continuous spinal anesthesia are reported, and from them the following conclusions are drawn: 1. There is no evidence that removal of spinal fluid shortens anesthesia. 2. The reactions of the patient to reflexes arising in the upper abdomen are accentuated by this method. 3. Morphine and scopolamine were best of the drugs tried by us to control these reactions. 4. Postoperative complications are slightly reduced by use of this method.

DISTRIBUTION OF CASES

Stomach operations	110
Partial colectomy	84
Expl. laparotomy, minor proced.	81
Abdomino-perineal resections	57
Biliary tract operations	33
Herniorrhaphies	20
Aneurysms	15
Spleen and pancreas	8
Appendectomy	7
Operations on extremities	7
Total	422

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