CLINICAL EVALUATION OF HYPOTENSIVE ANESTHESIA * †

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HYPOTENSION frequently follows the administration of spinal anesthetic agents. It has been looked upon as an untoward reaction and something to be avoided. The physiological characteristics of hypotension, as postulated by Smith *et al.* (1), are well known. It was not until Gillies (2) pointed out the advantages of the hypotensive spinal that this method of anesthesia has come under investigation.

This report is concerned with the clinical application of hypotensive anesthesia in 63 patients from 20 to 89 years of age. Figure 1 graphically demonstrates the age distribution of the patients in this report. The patients were selected from among candidates for spinal anesthesia. The graph reflects the age distribution typical of the age groups coming to surgery and is not planned to follow any particular pattern.

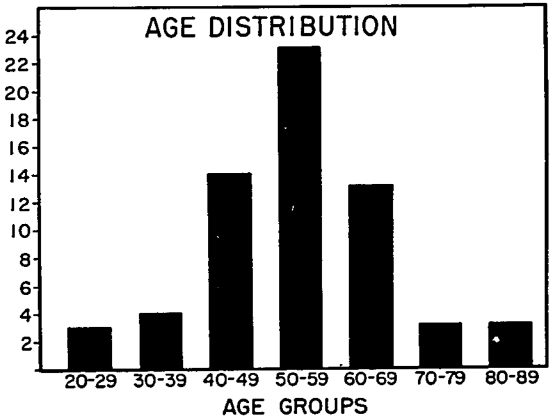

FIG. 1.

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Figure 2 shows the duration of hypotension, arbitrarily set at 80 mm. of mercury systolic or below, lasting from thirty minutes to seven and a half hours. The duration of hypotension corresponds to the duration of the surgical procedure in each case. There were no instances in which episodes of prolonged hypotension extended into the postoperative period. Hypotensive anesthesia was attempted in a number of other cases, but a satisfactory fall in blood pressure did not occur even though the level of anesthesia reached the sixth thoracic segment. In some of these cases a transient fall in pressure was observed, but did not persist. These cases are not presented or dis-

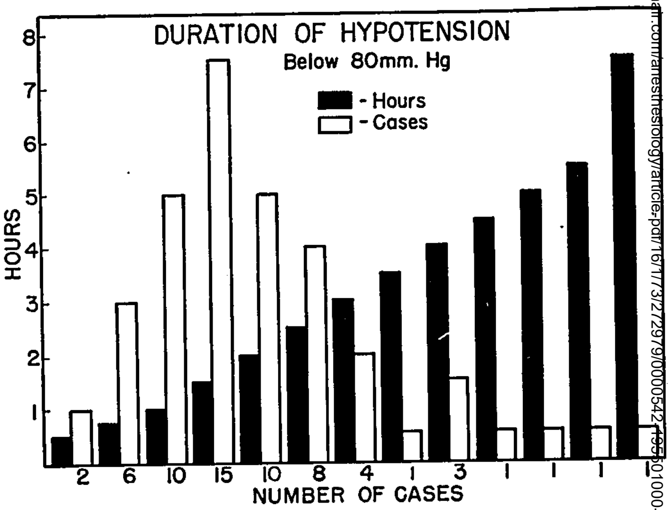

FIG. 2.

cussed in this report. The reason for these failures is not apparent, but failure is thought to be the result of the method of administering and managing the anesthesia.

METHOD

Three methods of achieving an effective sympathetic block were utilized in this series. They consisted of (1) single injection spinal analgesia, (2) continuous spinal analgesia and (3) continuous epidural analgesia.

The single injection spinal method was used in 37 cases. The puncture was performed at the third lumbar interspace with the patient in the lateral position. In this position the knees were drawn up and the neck was flexed to facilitate lumbar puncture by widening the intervertebral spaces. A 22 gauge needle was inserted and 1.5 cc. of a hyperbaric solution of 10 per cent dextrose containing 10 mg. of tetracaine was injected. The table was tilted from 5 to 10 degrees in the Trendelenburg position to carry the level of analgesia to the sixth thoracic segment. Care was taken to keep the patient's head supported on a high pillow, thus preventing the hyperbaric solution from reaching and affecting the cervical outflow. A vasopressor was not given.

Continuous spinal anaglesia was used in 22 cases in much the same manner as described above. A number 4 ureteral catheter was inserted through a 16 gauge Tuohy needle into the subarachnoid space for a distance of 6 cm. This technique was employed when it was estimated that the surgical procedure would last longer than one hour. A solution of 2.5 per cent procaine in Ringer's solution was used. The initial dose varied from 75 mg. to 125 mg. Repeated injections of 25 mg. were given as required to relieve discomfort or to keep the blood pressure at the desired level.

The catheter technique was also utilized for epidural analgesia in 4 cases. A 2 cc. syringe with a freely movable plunger, partially withdrawn, was affixed to the hub of a 16 gauge Tuohy needle, and inserted at the eleventh thoracic interspace. As the tip of the needle entered the epidural space, the plunger was drawn into the barrel a distance of 3 mm. A catheter was then passed through the needle into the epidural space for a distance of 4 cm. If difficulty was encountered in passing the catheter through the needle, a small amount of the anesthetic solution was injected through the needle. This forced the dura away from the needle tip and allowed the catheter to pass freely from the needle opening into the epidural space. The needle was then withdrawn and the catheter was allowed to remain in place. A solution of 1 per cent lidocaine was used to produce analgesia. The usual initial dose was 30 cc. and amounts of 5 cc. to 15 cc. were injected to continue analgesia as required. Oxygen was administered by face mask in each case.

RESULTS

The best results were obtained when the continuous spinal or continuous epidural techniques were used. Several observations were made which confirm those previously reported by Gillies (2) and Payne (3). Patients with low pressures did not develop the clinical picture that is characteristic of the shock syndrome. Even though the blood pressure fall was abrupt, there was no facial pallor and veins remained well filled. Tachycardia did not occur. Respiration remained slow. Pupils were constricted and the patients themselves showed no sign of anxiety or apprehension. The skin remained warm and dry. Table 1

TABLE 1

A COMPARISON OF THE PHYSIOLOGICAL CHARACTERISTICS OF HYPOTENSION AS PRODUCED BY ARTERIOTOMY AND SPINAL ANESTHESIA

Arteriotomy	Spinal Anesthesia
Blood pressure fall delayed	Blood pressure fall abrupt
Blood pressure fall moderate	Blood pressure fall profound
Tachycardia	Bradycardia
Facial pallor	No facial pallor
Skin cold and clammy	Skin warm and dry
No prominent veins	Prominent veins
Rapid respiration	Normal or slowed respiration

shows some of the clinical findings observed during hypotensive spinal anesthesia as compared to hypotension following arteriotomy.

An interesting observation made by the surgical staff as well as by the anesthesiologists was that the postoperative course of patients subjected to hypotensive spinal anesthesia seemed to be unusually good. For this reason the surgeons were never reluctant to operate when hypotensive techniques were employed. The added value of minimal blood loss combined with excellent relaxation has seemed to provide almost ideal operating conditions.

Shock was not evident in this series during anesthesia, although it is recognized that the shock syndrome could have been masked by the high spinal anesthesia. Magill (4), in 1952, stated that the clinical picture of shock does not occur in patients who have complete sympathetic block. Shock did not develop, however, in any patient during the postoperative period, as the anesthesia subsided.

The majority of patients remained awake during hypotensive anesthesia. In some cases drowsiness occurred which, according to Payne

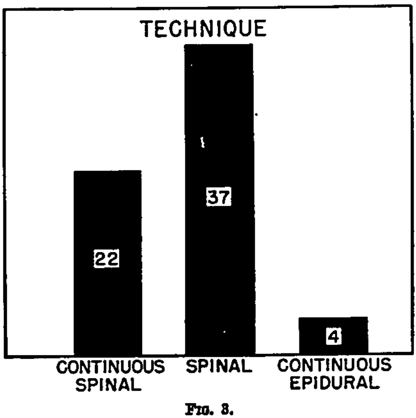

FIG. 3.

(3), may have been the result of reduced cerebral blood flow with accompanying mild hypoxia. There was no evidence of postoperative cerebral damage in any patient. It appears, therefore, that such manifestations, if due to hypoxia, are entirely reversible.

The experience gained through performance of the hypotensive technique has crystallized certain disadvantages. Internists and cardiologists alike have been unable to reconcile themselves to the principles of hypotensive anesthesia. Dripps and Vandam (5) have suggested that damage to the brain, heart, liver or kidneys may be associated with abrupt changes in blood pressure resulting from inadequate blood flow, thrombosis or spasm.

The mortality in this series is presented in figure 4. Three deaths occurred, which is a mortality rate of 4.7 per cent. This mortality compares favorably with that following normotensive spinal anesthesia as reported by Lorhan and Merriam (6). The deaths in this group are

MORTALITY

AGE	OPERATION	CAUSE OF DEATH	POST-OP DAY
59	SUPRAPUBIC CYSTOTOMY	CA PROSTATE PYELONEPHRITIS	35th
60	WHIPPLE	CA PANCREAS METASTATIC	4th
61	CHOLECYSTO-JEJUNOSTOMY	CA PANCREAS METASTATIC	28th

FIG. 4.

not necessarily related to the duration of hypotension or to age. The mortality is commensurate with the type of surgical procedure and the number of patients in the sixth and seventh decades. The estimated anesthetic risk as compared with mortality is shown in figure 5.

The exact cause of hypotension following spinal anesthesia has not fully been explained. Several theories have been reviewed by Papper, Bradley, and Rovenstine (7). Among the theories forwarded to explain hypotension following sympathetic block are: hematogenous intoxication, drug action on the medulla, paralysis of adrenal nerves with reduction in the secretion of epinephrine, the anoxia theory, the paralysis of vasoconstrictor fibers in the anterior spinal roots and stagnation in the postarteriolar bed. The last mentioned appears to be the most plausible explanation. The fall in blood pressure is primarily associated with a decrease in cardiac output. There is also an increased difference in arteriovenous oxygen. An increase in circulation time occurs, together with a fall in venous pressure. The thesis of arteriolar vasodilatation as the cause of hypotension is discarded in favor of the principle of postarteriolar bed stagnation.

Certain conditions are necessary for the satisfactory performance of the hypotensive technique. For example, oxygen deprivation can be catastrophic, which clearly bears out the fact that the hypotensive patient is keenly susceptible to hypoxia (1); therefore oxygen must be administered during anesthesia and until normotensive levels are established. The position of the patient is equally important (8). The Trendelenburg position is essential to insure the gravitational flow of blood toward the heart. This aids the venous return to the heart and helps to maintain an adequate cardiac output. If these conditions are met satisfactorily, patients may tolerate drops in blood pressure to a

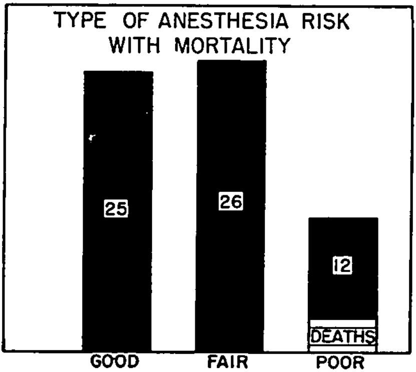

FIG. 5.

systolic level of 50 mm. of mercury without apparent untoward effects. Even at this level a pulse at the radial and temporal arteries is readily palpable.

It is not to be inferred that myocardial ischemia does not occur. In this series, premature ventricular contractions were observed in one patient and auricular fibrillation was noted in another. Both patients were poor risks with pre-existing cardiovascular disease. Levine (9) pointed out the dangers of hypotension among cardiac patients and suggested that normotensive levels be maintained. Myocardial ischemia may have been responsible for these arrhythmias, and its occurrence in the presence of marked hemodynamic alterations cannot be discounted. Arrhythmias were not observed in the good risk patients regardless of the severity of the fall in systolic pressure.

Restlessness, nausea and occasional vomiting were observed. In some cases, nausea occurred only when extremely stimulating maneuvers were attempted, giving rise to reflexes over pathways not obtunded by high spinal anesthesia. Tension on the mesenteric attachments of the gastrointestinal tract, and manipulation of the liver, spleen or kidneys have produced nausea. Although restlessness has been described as one of the manifestations of hypoxia, it also occurs with nausea or even discomfort of the patient on the table; therefore the exact mechanism of this particular sign can only be a matter for speculation. It may be associated with hypoxia but it also occurs in the presence of other factors.

All of the contraindications to spinal anesthesia must apply when the hypotensive technique is employed. Particular attention is directed to the following:

1. Blood must be immediately available. This is necessary because reflexes do not function to bring about a compensatory readjustment following changes in circulating blood volume as the result of hemorrhage.
2. Oxygen must be administered.
3. The use of hypotensive anesthesia should be restricted to situations in which a bloodless field is of vital importance to the patient and the surgeon. If unusually large blood loss is anticipated, the conservation of blood may be essential.
4. Although shock is a contraindication for the use of spinal anesthesia, it is even a greater threat if the hypotensive state obtains. Compensatory mechanisms do not operate to protect the patient or warn the anesthesiologist of impending circulatory collapse. The importance of a careful preoperative evaluation, therefore, cannot be overemphasized.
5. Anemia and a reduced circulating blood volume are definite contraindications to the use of the hypotensive techniques.

Two readily available laboratory observations, urinary output and hematocrit readings, contribute to the clinical appraisal of hypotensive anesthesia.

Urinary Output. The urinary output was carefully measured in a number of patients. An oliguria was often observed for a period of twenty-four hours after operation. Diuresis then followed, lasting twenty-four to forty-eight hours, after which the urinary output returned to normal levels. In no instance was anuria observed, nor did oliguria persist.

Hematocrit. Hemoconcentration was noted in 2 instances during the early postoperative period. This occurred without blood transfusion and in spite of administration of intravenous fluids. This may have been an unseen manifestation of a shock-like condition that developed either during operation or early in the postoperative period.

No clinical signs of shock were noted. The phenomenon, therefore, is unexplained.

CONCLUSION

The advantages of the hypotensive technique, as previously asserted by Gillies (2) and Payne (3), have been borne out by this series. It has been possible by this means to conserve blood with its attendant benefits to both patient and surgeon. The disadvantages are, perhaps, more implied than real, but must be seriously considered by any one contemplating use of the technique. It is the authors' opinion that hypotensive anesthesia, of necessity, is limited to use by anesthesiologists thoroughly acquainted with the use of spinal anesthesia together with all of its circulatory and neurological implications. It should be attempted only under ideal circumstances, when blood, oxygen and resuscitative equipment are at hand. It is doubtful whether the method will ever attain a wide field of usefulness or deserve a wave of popularity. As evidenced by the 63 cases reported in this paper, however, this technique can be employed with advantage if it is planned with the patient in mind.

SUMMARY

High spinal anesthesia as a means of producing a state of hypotension during operation was subjected to clinical evaluation in 63 cases.

A dry surgical field with resultant conservation of blood for the patient are the advantages to be expected from this technique.

Spinal or epidural anesthesia is employed to obtain an effective sympathetic block up to the first thoracic segment. The Trendelenburg position is essential to insure an adequate venous return to the heart and to prevent a drastic fall in cardiac output, with resultant cerebral anemia. It is emphasized that oxygen must be administered by face mask until normal blood pressure levels are established.

Among the several theories forwarded to explain hypotension following sympathetic block, the theory of postarteriolar bed stagnation seems the most plausible. The dangers of hypotension are not overlooked. The technique has been criticized on theoretical grounds, but clinical experience indicates the method may have merit in selected cases in which large blood loss is anticipated.

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