THE CONTROL AND MANAGEMENT OF HYPERTENSIVE CRISES DEVELOPING DURING SURGICAL PROCEDURES

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THE maintenance of normal blood pressure during surgical intervention and anesthesia has been a postulate, violated only with fear and trepidation, up to very recently. The concept of controlled hypotension during operations and anesthesia is a relatively new one, and its safety, indications and contraindications have yet to be fully established (1–4). Much physiologic and pharmacologic research is still needed to establish a clear and definite answer regarding the safety of controlled hypotension.

With the introduction of new types of drugs into the armamentarium of medicine, new methods of controlling blood pressure have been developed. Two pharmacologic methods of reducing blood pressure are available today for use in the unanesthetized patient. These are ganglionic and effector organ blocking agents. Similarly, drugs are available to increase blood pressure, that is, peripheral vasoconstrictors and drugs that primarily increase cardiac output. By using either type alone or in combination, blood pressure can be maintained at almost any previously specified and selected level. These methods can be used during anesthesia for surgical procedures.

The purpose of this study is to present a method for controlling hypertensive crises (5) arising during anesthesia for varied surgical procedures.

The use of ganglionic blocking agents for the reduction of blood pressure in the medical treatment of hypertension has been fairly well established (6).

The studies of Paton and Zaimis (7, 8) in their search for an antagonist to decamethonium or syncurine® established the ganglionic blocking activity of certain members of the polymethylene-bis-trimethyl ammonium series of the general formula $(CH_3)_3N(CH_2)_nN(CH_3)_3$, where $n = 5$ or 6. (Decamethonium is a substance of the same series where $n = 10$, and is commonly called C10.) Hexamethonium bromide, C6, where $n = 6$, has been found to be the most satisfactory for this

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purpose. On the basis of this work several studies were carried out on the use of hexamethonium bromide for the treatment of hypertension. Finnerty and Freis (9) concluded that hexamethonium bromide (C6) inhibited or abolished sympathetic and vasopressor reflexes and neurogenic spasm and could be used to control the blood pressure in hypertensive states. Smirk and Alsted (10), on the basis of current and past studies, stated that hexamethonium bromide can control hypertension in many instances regardless of its etiology.

In an attempt to prevent or reduce bleeding during surgical intervention, hexamethonium bromide has been used extensively to reduce normal blood pressure to a hypotensive level. This is the most favored technique for producing controlled hypotension. The surgical and anesthesiologic literature is replete with articles on this subject and nothing further need be said here regarding this problem (1–4).

The need for the control of hypertensive crises developing before or during operation became especially evident during cystoscopic examination on paraplegics with spinal cord transection at the fifth thoracic segment or above, and on quadraplegics. Our hospital has a large rehabilitation service and urologic examinations on such patients are frequent. The hypertensive crisis developing in these patients during surgical manipulation or distention of a hollow viscus is an abnormal response which we believe should be treated by ganglionic blocking agents.

Guttman and Whitteridge (11) were the first to observe that patients with transection of the spinal cord at the level of the fifth thoracic segment or above obtained massive effects on the autonomic nervous system when distention of a hollow viscus, particularly the bladder or rectum, occurred. They reported that in patients with complete transection of the cord at or above the fifth thoracic segment, vasoconstriction of the toes is accompanied by vasoconstriction in the fingers and a conspicuous rise in blood pressure, a marked decrease in the pulse rate and changes of rhythm in the electrocardiograph; in particular, extrasystoles and increase of the U wave were observed. A remarkable vasodilatation in the neck, face and nasal mucosa occurs at the same time. The vasodilatation of the nasal mucosa may lead to complete blockage of the nasal air passages.

Certain components of the autonomic reflex responses occurring above the level of the lesion, such as flushing, sweating in face and neck, blockage of nasal air passages, and headaches, represent alarm symptoms indicating abnormal activity of a viscus in the anesthetic area below the level of the lesion. This response is called the "mass autonomic reflex."

Our first experience with the mass autonomic reflex is shown in figure 1. The injury in this case was at the level of the seventh cervical segment. On neurologic examination small areas could be found that

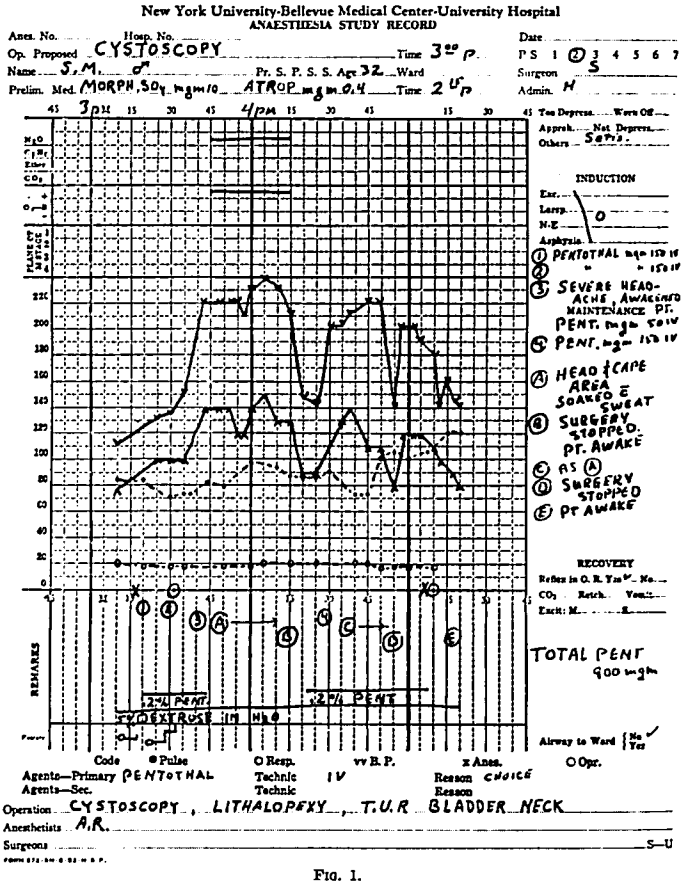

FIG. 1.

responded to pin prick, especially around the inguinal ligament (eleventh and twelfth thoracic and first lumbar). Touch sensation could be elicited over both lower extremities. The patient manifested the typical mass autonomic reflex response to distention of the bladder (even headache and sweating of the cape areas) as described by Guttman and Whitteridge (11).

The chart shows the rapid fall in blood pressure after emptying of the bladder and the recurrence of hypertension when refilled. These exaggerated responses to relatively minor surgical procedures prompted us to investigate this problem. During this procedure the patient was asleep with 0.2 per cent pentothal® by intravenous drip and nitrous oxide-oxygen by the semiclosed technique.

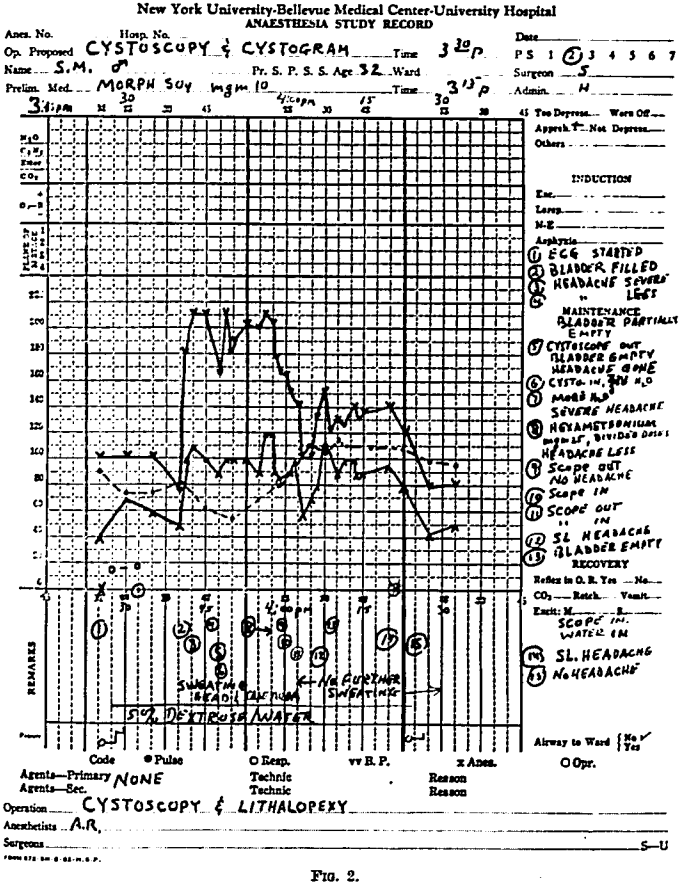

FIG. 2.

Because of the known hypotensive activity of the hexamethonium ion it was decided to use one of these, hexamethonium bromide, in other cases in which similar lesions were present. The above-mentioned patient came to the operating room on many occasions and figure 2 shows a subsequent course of events without the benefit of anesthetic agents. He was first examined without the use of a gan-

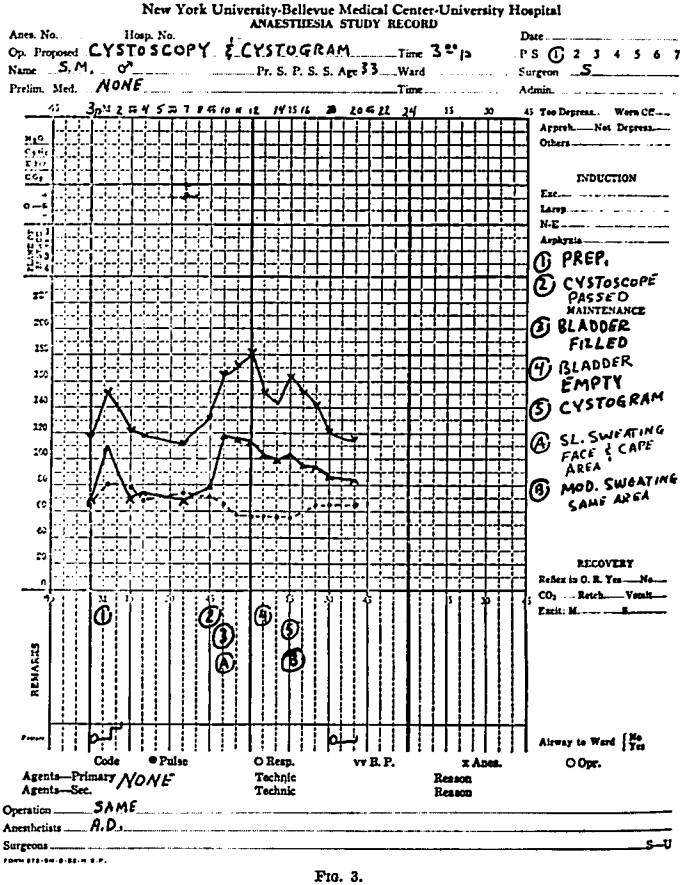

FIG. 3.

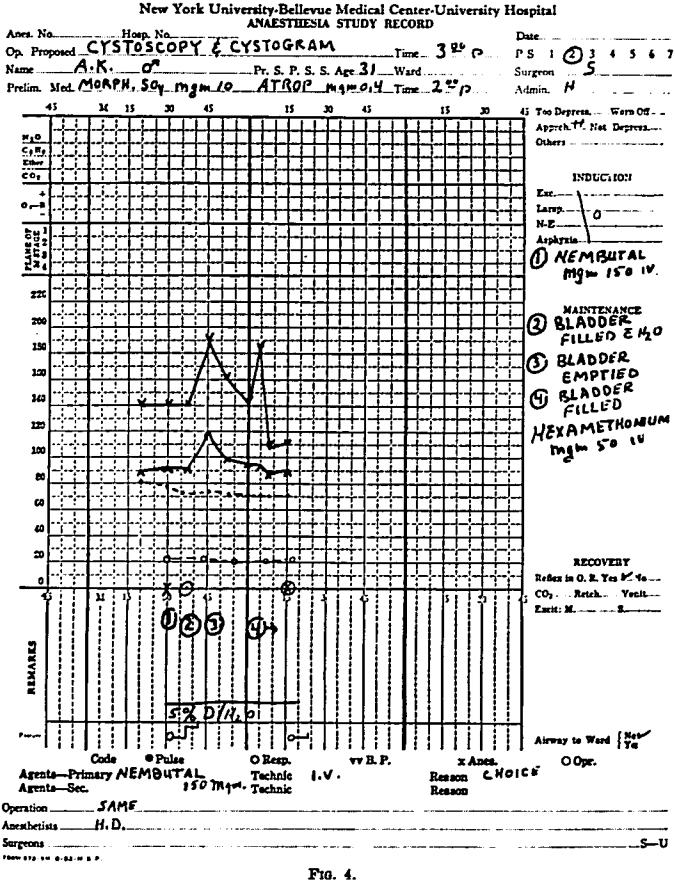

FIG. 4.

glionic blocking agent and showed what we now know to be a typical mass autonomic reflex response. He was then given hexamethonium, 25 mg., in divided doses and the blood pressure fell to a normal level. On refilling of the bladder there was a moderate rise in blood pressure and a slight headache developed. The headache disappeared and the blood pressure returned to normal when the examination was discon-

tinued. This indicated to us that the mass autonomic reflex could be controlled by the judicious use of small amounts of hexamethonium bromide. Continuous electrocardiograms taken during this examination showed only changes in rate but no arrhythmias.

Figure 3 shows the same patient just before discharge after rehabilitation. There was little if any neurologic improvement, but less distention of the bladder was required for this examination and substantially less hypertension, headache or sweating developed, demonstrating that the mass autonomic reflex response is proportional to the intensity of the stimulus.

The next patient studied, figure 4, had a complete transection of the cord at the level of the fourth cervical segment. He manifested a rise of blood pressure on filling the bladder and a return to normal on emptying, a typical mass autonomic reflex response. The subsequent rise in blood pressure developed on refilling the bladder and hexamethonium was injected intravenously, causing a dramatic fall in blood pressure. Following this, the bladder was emptied slowly. Here again we were able to control the mass autonomic reflex with hexamethonium bromide.

To date we have employed one of the hexamethonium salts in six such examinations of patients with spinal cord transections at the fifth thoracic segment or above. In each instance we have allowed the mass autonomic reflex response to develop (it has never failed to develop upon surgical stimulation), and in each instance we have subsequently been able to block the response with hexamethonium.

The occurrence of hypertension in patients who have expanding intracranial lesions is a well established fact, although the physiologic explanation of this phenomenon is not clear. It was decided to try hexamethonium bromide in cases of this type.

Figure 5 shows a typical chart of such a case. This patient had a blood pressure in the ward of 124 mm. systolic and 80 mm. diastolic. His condition suddenly deteriorated and he came to the operating room as an emergency in coma and with a blood pressure that had climbed rapidly to 220 mm. systolic and 120 mm. diastolic. Hexamethonium, intravenously, caused a very rapid fall in blood pressure to 96 mm. systolic and 74 mm. diastolic. Repeated small doses were required to maintain the blood pressure at the selected level, that is, a systolic level of approximately 120 mm. of mercury.

This technique was employed in only 2 cases, with satisfactory results.

The control of hypertensive crises that occasionally develop during surgical intervention for Grave's disease has always been and continues to be of great concern for the anesthesiologist. In no type of surgical procedure is hypertension so disconcerting to the anesthesiologist and surgeon alike. It was decided to study the effect of ganglionic blocking agents in such conditions. Figure 6 is a study record

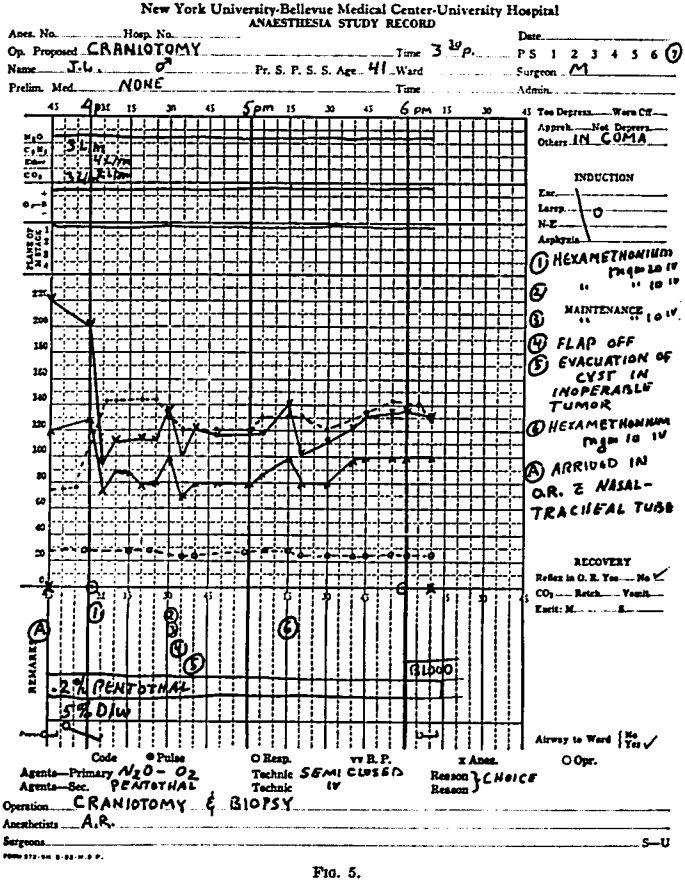

FIG. 5.

of such a case. This patient had a blood pressure in the ward of 246 mm. systolic and 128 mm. diastolic. After induction of anesthesia and the beginning of operation her blood pressure rose to above 300 mm. systolic and 140 mm. diastolic. The systolic level is unknown to us since our manometer does not register above 300 mm. of mercury. The anesthesia management and technique were carefully checked

and no mechanical causes could be found to explain this state. Hexamethonium ion, 25 mg., was injected intravenously causing a drop of blood pressure to 160 systolic and 100 diastolic, with a further fall to 120 mm. systolic and 90 mm. diastolic. A concomitant decrease in pulse rate also occurred; respiratory rate and amplitude continued unchanged. The blood pressure gradually rose again to 170 mm. systolic and 120 mm. diastolic, and stabilized at this level.

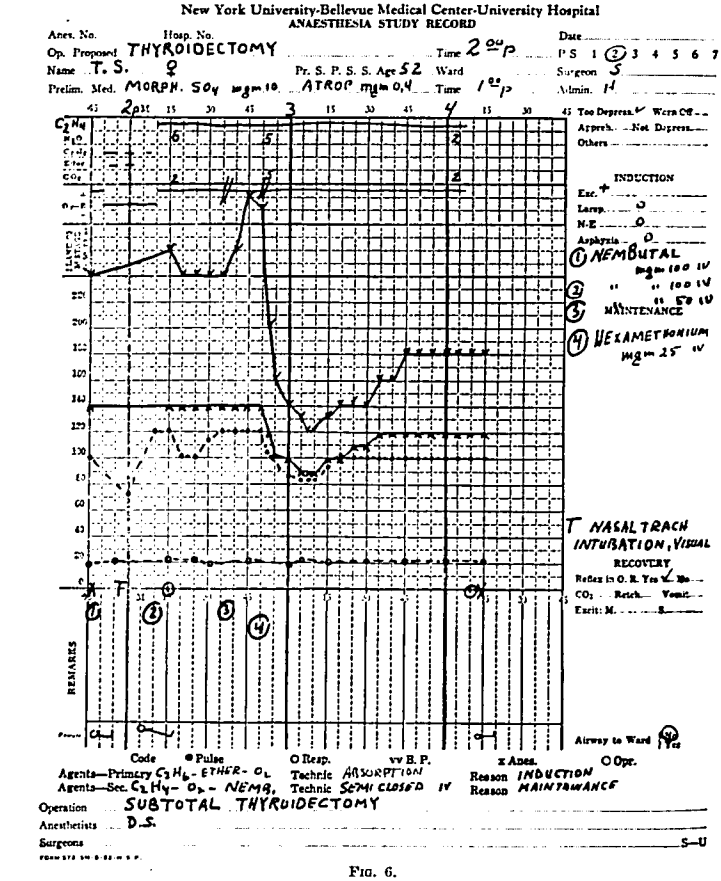

FIG. 6.

DISCUSSION

The cases reported reflect hypertensive states, the cause of which is reflex in origin. Transgressions in anesthetic technique, we believe, are not to be implicated. None of these reported cases, at least clinically, manifested signs of obstructed airway, inadequate ventilation, or excess of carbon dioxide.

In this series of cases the ganglionic blocking agents were not employed to produce hypotension but to control abnormal autonomic activity. The indication for the use of these drugs to control such activity is a concept which we believe is physiologically sound and one which deserves wider clinical application.

The degree of hypertension resulting in individuals whose spinal cord is transected at the fifth thoracic level or above varies proportionately to the degree and the rapidity of distention of the viscus. Mild or moderate distention of the urinary bladder results in less severe systolic rises than those produced by abrupt, rapid overdistention.

A study of the cases presented clearly indicates that the response is graded to the stimulus. The "all-or-none" principle does not seem to apply in the mass autonomic reflex response.

The literature abounds with case reports pointing to the fact that at times it is difficult, if not impossible, to produce hypotension in a normotensive individual. We concur in this observation. When abnormal hypertension is a presenting sign, however, ganglionic blocking agents in every instance have produced the desired, controllable, and predictable effect.

CONCLUSIONS

Some types of hypertensive crises seen by the anesthesiologist are discussed.

A method, the use of hexamethonium ion, to control hypertensive crises is presented.

Case records demonstrating the controllability of the method are reported.

Its clinical applications are discussed.

This report is based on 18 cases. Since that time a total of 24 cases has been successfully treated.

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